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Women in mathematics education: pathways to participation

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WOMEN IN MATHEMATICS EDUCATION: PATHWAYS TO PARTICIPATION

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"Be present in all things and thankful for all things"

– Maya Angelou

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My thesis is dedicated to my children.

I dedicate this to you, my little loves, in hopes that when you are old enough to go to school you will experience mathematics education in a way that inspires you.

Love always, Mama.

Abstract

Improving the participation of women in mathematics education at the post-secondary level, requires a deeper understanding of how women orient themselves within two very distinct domains: *mathematics* and *education*. Each domain holds competing ideas of the purpose of mathematics, including who should participate, which further adds to the complexity of how women position themselves at the intersection in the field of mathematics education. This narrative inquiry highlights the personal pathways—including experiences, thoughts, and stories—to becoming a woman mathematics educator at the post-secondary level. The research questions guiding this inquiry are: *Why do women decide to teach mathematics education at the post-secondary level? What are the experiences of women mathematics educators who had "overcome barriers"? What are the critical moments along their pathway to participation?*

This inquiry brings together critical feminist theory, psychoanalytical perspectives, and social constructivist theory to understand the perception of women, the complexity of their gender identity, and how their experiences in mathematics education influence their participation in mathematics. A semi-structured interview was conducted with 5 participants to examine the lived experiences of women in mathematics education, followed by a critical self-reflection to discuss the critical moments to becoming a mathematics educator. The data analysis consisted of two phases. *Within* narrative analysis involved re-storying of lived experiences and *across* narrative analysis identified major themes across the women's experiences and their journey towards mathematics education.

The study concludes by offering suggestions to improve the participation of women in mathematics with a particular focus on the importance of storytelling.

CONTENTS

Chapter One

Introduction and Framework

Now I become myself. It's taken
Time, many years and places;
I have been dissolved and shaken,
Worn other people's faces…

—May Sarton, "Now I Become Myself"

Preamble

I have a purpose; a powerful voice to do good in this world. I am resilient and determined. I am a woman, a feminist, an educator, a student, a mother, a partner, a daughter, and a sister. I am learning. I am anxious. I am creating my own path and I am present for all the incredible awakenings along the way; for this will shape my future.

As I reflect on how I came to study women in mathematics education, I remember a piece of advice given to me by my faculty advisor, in the Bachelor of Education program. She said, "if you're uncomfortable teaching math, make sure you teach math every chance you get." These words both terrified me and empowered me all at once. During my first teaching placement, I was paired with the 'school math lead', and together we made mathematics a priority. We attended professional development workshops on how to teach math, and I began to feel my confidence—as a learner and as an educator—rise. My placement experience pushed me well beyond my comfort zone and forced me to see that I was never inherently bad at math. I lacked confidence. The literature is very clear in stating that women tend to be more self-critical and view themselves as less competent in mathematics regardless of their ability (Ellis et al., 2016; Hango, 2013; Herbert and Stipek, 2005). I believe that this is a result of societal expectations suggesting that women "don't belong" in mathematics, and the images that women are

bombarded with from the media that place extraneous pressure on girls to conform to femininity, something that is not associated with mathematics (Jacobs, 2010; James, 2009; Lim, 2012). As I challenged my perceptions of women in mathematics, I unveiled deeper issues of gender bias and considered how it might influence women's participation in the field of mathematics education.

This work is a reflection of my past, my present truth, and will continue to be the pathway that defines my future. My pathway to participation in mathematics unfolds through internal stories and reflective thought, with the use of italics, like the paragraph that introduced this chapter. I weave these narratives throughout my work for two reasons. One, I do this to disclose my positionality and subjectivities as a researcher. Two, storytelling is dialogic and influenced by time and context (Pinnegar & Daynes, 2007). To exclude my autobiographical presence as a researcher, engaging with content that is personally meaningful, would constitute a deception about the epistemological status of the research (Clandinin & Connelly, 2000).

This qualitative inquiry highlights women's perspectives, identities, and experiences relating to their decision to teach mathematics education at the post-secondary level. I have been entrusted with the stories of mathematics educators and as a result, I have gained a deep appreciation of how experience influences participation in mathematics, and the real and perceived barriers that they have had to overcome. I have learned that for some women, the journey to becoming a mathematics educator involves a deep desire to help others, followed by personal transformation and the attainment of an important life milestone.

Exploring my Pathway to Participation

There is much to share about my experiences with mathematics—as a researcher, a teacher, a financial advisor, a student, and a mother. I begin by acknowledging my voice as a

researcher to define how my presence affects the story. To provide context for following chapters, I share three critical moments along my pathway to becoming an advocate for women in mathematics.

Critical Moment 1: Entering High School Mathematics

The day was filled with anticipation. I entered the doors of my new high school and felt the feeling of independence. Hallways were crowded with familiar faces, but everything was different. We had left the comfort of our home in elementary school and embarked on a new journey, one that would allow us to redefine our path and shape who we are. It's not that I didn't like who I was in the past—I left my mark in elementary as the Valedictorian—but I knew that that version of myself would never stand a chance in the competitive social arena, that was my new high school. I glanced anxiously at my timetable and saw that my next class was math. Math was never my favorite subject and certainly not my highest grade, but there I was, placed in the academic stream. The assumption was that being placed in the academic stream meant that you were smart. Until that point, I had attributed my success in mathematics to my parents and educators. My parents always dreamed big for me and challenged me academically. They believed I was capable of anything and feared that exclusion from mathematics would limit my future career opportunities. My teachers in elementary school took the time to understand what worked for me and encouraged me to succeed. As I opened the door to my high school math class, I was comforted in seeing my friends who reassured me that we would survive the class together. Little did I know, the teacher of this class would hold so much power over my pathway to participation in mathematics. When the time came for parent teacher interviews, I was sitting at a 36% in the course. Embarrassed and ashamed, I told my parents I was ready to accept my

defeat and transition into the applied stream[1] of mathematics. Everyone knew that this transition would instantly close doors to my future ambitions. My mother fought long and hard that semester, trying to get me the support I needed to succeed, but the loss was inevitable. The average of our high school math class was 26% and it didn't matter how many tutors got involved, the teacher's response was simply this: "it's a big jump from grade 8 to grade 9 and either students get it, or they don't." Those words hung over me for many years because it was that very moment where I accepted that I was someone who "didn't get mathematics".

Critical Moment 2: The Power of Confidence

Towards the end of high school, I became interested in business and more specifically, interested in the idea of being a woman in that sphere. I was on a mission to prove that I was capable of being intelligent. I felt discouraged knowing that the pathway to my goals would be different than my peers. Without academic math, I'd need to attend college and complete an advanced diploma before transitioning to university to complete a business degree. What I viewed as a setback, launched me into one of the greatest experiences of my life. I arrived in a new city that I would later call home and immersed myself in opportunity. I received an offer to work at a financial institution and discovered the affirmation I was searching for. I was empowered to be working alongside my male counterparts, many of which held business degrees from respectable universities. I started to feel a sense of belonging. As I progressed in my career and my schooling, my encounters with mathematics became more difficult. One exam in particular, relied heavily on mathematics but I knew it would allow me to advance my career. My commitment to becoming a woman of influence was in motion, but the fear of failure

[1] In Ontario, as of 2020, three streams (pathways) for mathematics education exist at the secondary level: locally developed courses, applied courses and academic courses; each pathway determining a future destination. This topic will be elaborated on in future sections.

loomed, bringing feelings of self-doubt and insecurity. Overcoming the dreaded mathematics exam was a turning point for me. This shift in perspective can be eloquently summarized through the words Reisman and Kauffman (1980) who said:

> In our culture, mathematics is a powerful tool. Successful performance in mathematics carries with it positive connotations. Being "good in math" is "being bright", and being bright in mathematics is associated with control, mastery, quick understanding, [and] leadership. Unsuccessful mathematics achievement implies the opposite of these positive connotations. (p. 36)

I began to think differently about myself and my identity, my experiences, and my worldview. For the first time in my life, I regarded myself as smart in mathematics and with that came great power. The power came from knowing that I was part of something greater—patriarchy—and I understood that my success as a woman in this space had the potential to influence how others experience male-privilege (Harding, 2004; Hartsock, 1998). The public's perception of mathematics is still one that dictates who can participate in mathematics and who constitutes as "more knowledgeable" in society. Participation in mathematics gave me a voice and sense of authority over those who remained on the outskirts of mathematics. It also provided me with an opportunity to make mathematics meaningful and discover the mathematical connections that exist between myself and the world around me.

Critical Moment 3: Becoming a Changemaker

Two years ago, I began my master's journey with trepidation. I was gaining confidence in myself as an educator and was passionate to learn more about women in mathematics. The decision to pursue a thesis was overwhelming and driven by my desire to further my education with the ultimate goal of obtaining a Doctor of Philosophy. I had never viewed myself as a writer

and had very limited experience with research. I entered my first online research methods course feeling intimidated and uncertain. I would sit at my desk reading posts from my peers thinking, there's no way I can even come close to their caliber of writing. I reflected on my feelings of inadequacy in mathematics and remembered how far I had come. I considered the possibility of completing a master's thesis. I was determined to challenge myself in hopes that it would open unimaginable pathways for women educators in mathematics. Perhaps this was a beautiful dream and in fact, a bit grand. I persisted with a mindset of encouraging all my students to have grand plans. I began to think about what my research might look like. Inevitably, discussions of research methodology emerged, and I knew that my research needed to amplify the voices of women in mathematics education. I wanted to hear their stories and learn from their experiences. I also knew that my own positionality was important to disclose throughout, as I intended to discuss content that was personally meaningful. The methodology of narrative inquiry was a natural fit as it is grounded in the belief that experiences can be told, re-told, understood, and re-presented through stories. Narrative can be understood as "a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected" (Czarniawska, 2004, p. 17). Stories are a natural form of discourse in daily interactions, so they serve as an authentic lens to view how individuals understand experiences and construct meaning in their lives. To accept "lived experiences as phenomena" (Connelly & Clandinin, 2006, p. 375), narrative provides an opportunity to interpret the social, cultural, and historical context from many different perspectives, and discover how stories are deconstructed to reveal "powerful discourses, hierarchies, presuppositions, deliberate omissions and polar opposites" (Grbich, 1999, p. 52). Narratives then, are accepted as knowledge, as social reality, and representative of

the richness and messiness of life (Etherington, 2017). A distinct feature of narrative inquiry is the orientation concepts of time and place.

Time is an important reference point when locating individuals, events and or ideas (Connelly & Clandinin, 1990). It is the understanding that "every event is an expression of something happening over time: it has a past, present, and implied future" (Schram, 2006, p. 105). Further, that those events can be chronologically ordered to make meaning of an experience. Similarly, place provides the situational knowledge that is required for understanding the social-cultural context of experience (Connelly & Clandinin, 1990). Therefore, narrative researchers understand that our identities are inextricably connected with our experiences in a specific place and how we share stories in relation to the experience within the place. Individuals in academia tend to progress through the following stages of education: elementary school, secondary school, higher education, and then enter the workforce. The concept of time was particularly important to my study as it allowed for comparison of women's experiences at similar stages regardless of the total length of time spent in and out of education. Therefore, while it was expected that a woman who attended school twenty years ago may have experienced various transitions along her pathway to becoming a mathematics educator, her recollection of education and her learning of mathematics was compared to the same educational phase of a woman who attended five years ago. The orienting concepts influenced my decision to pursue narrative inquiry as my research questions explore how women understand their pathway to participation in mathematics and their identity by locating events and perceptions in time.

Purpose of the Inquiry

It has been challenging to establish a universal framework in mathematics education given the diverging theoretical perspectives of the discipline (Degu, 2015). Women working in

the field of mathematics education are uniquely situated in the intersection of *mathematics* and *education*; each discipline holding its own philosophies and epistemologies that are influenced by culture, social, and political forces. My inquiry investigates the personal pathways—including experiences, thoughts, and stories—to becoming women mathematics educators at the post-secondary level. My interest lies in the progress of women throughout their course of study in mathematics, to gain a better understanding of how their perceptions influence their participation. Socialization is commonly ascribed to the disparity of women in mathematics; therefore, my study also explores various factors such as family beliefs, teachers, and gender identity, that have encouraged or limited women's participation in this area. At the heart of this inquiry are the voices of women mathematics educators, currently teaching at the post-secondary level. Their stories need to be heard because they reveal the impact of societal views and signify much about gender bias related to women and mathematics.

Research Questions

During my Bachelor of Education, I developed an appreciation for the various ways that individuals learn mathematics. As I stepped into the world of discomfort, I witnessed a change in my own perceptions of myself as a learner as well as my peers who became empowered by new access to mathematical knowledge. Women educators inspired me, and they sparked curiosity as to how they became mathematics educators at the post-secondary level. I wondered if they were always confident in mathematics or if they had overcome perceived barriers themselves. As I situate myself within the literature, I realize how entangled our experiences (past, present or future), the sociality (the ways in which our experiences intersect with socio-cultural influences) and place (the physical and topological locations) are, in forming women's identity in mathematics education. There is an abundance of literature on mathematics and mathematics

education that tends to focus on each discipline as an independent domain. My research provides an opportunity to bridge the gap and discuss the interconnected relationship between mathematics, mathematics education, and the influence on women's participation. It is anticipated that participants will gain a deeper understanding of their role as women in mathematics and what they bring to the field of education. I recognize the value in listening to women's voices and the diverse experiences that enabled them to overcome the negative perceptions and led to their current positions. Their perspectives and stories help me to understand how educators can encourage more women to develop positive dispositions towards mathematics. Further benefits include viewing different perspectives and potentially enabling new initiatives at the post-secondary level to support women in mathematics education. By extension, my research might also benefit pre-service teachers by providing a shift in their pedagogical thinking to be more responsive to gender as part of mathematics instruction.

This qualitative study is grounded in feminist methodology and seeks to strengthen the conversation about mathematics education. Feminist research suggests that we have inequalities of gender and sex, and we need to give more attention to gender as part of our learning in mathematics. My research brings together feminist research and mathematics education in an attempt to bridge the gap and promote women's participation by exploring the perceptions of women, the complexity of their gender identity, and their lived experiences in relation to the field of mathematics education. This inquiry empowers women's voices in matters that directly affect them; namely their pathway to becoming a mathematics educator at the post-secondary level.

Two key questions are addressed:

1. Why do women decide to teach mathematics education at the post-secondary level?

2. What are the experiences of women mathematics educators who had "overcome barriers"? More specifically, what are the critical moments along their pathway to participation?

The first question developed out of a natural curiosity about how women arrived at a career in mathematics education. It sought to understand who we, as a society, believe should engage in mathematics and how teaching practices are influenced by these notions. My second question aims to understand more deeply how perceptions influence women's participation in mathematics. Based on these questions, the inquiry explores how women's identities are constructed and how they interact within an educational system that serves as a problematic gatekeeping function. A review of the complexities of gender identity can provide multifaceted knowledge that is required for new systems of equity that promote positive learning experiences for women in mathematics.

Theoretical Orientation

"We may not be able to dismantle our culture's patriarchy, but we have an opportunity to rid interpretative research of its narrative coercion"

(Gudmundsdottir, 2001 p. 236–237)

Sex and Gender Defined

Gender differences in participation in mathematics are helpful in providing an overview of the dominant trends of women in mathematics. Early research of women in mathematics used the term *gender* to indicate that a difference in mathematics performance or participation was unlikely to be attributed to biological differences (Leder, 2019). Early feminists attributed bodily sex to the "corporeal facts of our existence" and gender as "the social conventions that determine differences between masculinity and femininity" (Dino, 2002, para. 3). Throughout this inquiry,

I will use the terms gender and sex interchangeably following gender theorist, Judith Butler's, critique of such distinction. Butler (1999) argues that the distinction between sex and gender is intangible stating:

> If the immutable character of sex is contested, perhaps this construct called 'sex' is as culturally constructed as gender; indeed, perhaps it was always already gender, with the consequence that the distinction between sex and gender turns out to be no distinction at all. (p. 10–11)

Butler suggests that "gender reality is performative which means, quite simply, that it is real only to the extent that it is performed" (Butler, 1988, p. 527). She further claims that gender fails to recognize the "multiplicity of cultural, social, and political intersections in which the concrete array of 'women' are constructed" (Butler, 1999, p. 19–20). For Butler (1988), socially constructed accounts of shared femininity have invertedly defined what it means to be a woman. She suggests that this notion implies that there is some "correct way to be gendered a woman" (Butler, 1988, p. 5). Similarly, Butler (1988) argues that sex is "not a bodily given on which the construct of gender is artificially imposed, but a *cultural* norm which governs the materialization of the bodies" (p. 8). The idea that sex is a social construct, suggests that our sexed bodies are also performative and have "no ontological status apart from the various acts which constitute [their] reality" (Butler, 1999, p. 173).

The term gender identity is used to describe how women construct their identity based on gendered messaging, and ideas about what it means to be female while managing the traditionally feminine roles that are assumed in society, based on sexual orientation. I recognize that gender is further shaped by race, class, sexuality, culture, and geography although my inquiry does not expand to that length. It is worth acknowledging however, that women who

belong to other minoritized groups "navigate a complex and contradictory set of messages" in order to navigate their identity, and have reported experiencing "racism, classicism, xenophobia and homophobia on top of sexism" (Ingram, 2013, p. 56). Undoubtably, these aspects extensively shape women's experiences and are important considerations even though they are not explicitly addressed within this study.

Critical Feminist Theory

My identification with a feminist agenda encourages me to use an approach rooted in equity and empowerment that advocates for education as growth and transformation. Feminism interrogates "pervasive inequalities and injustices in everyday social relationships" (Freeman & Vasconcelos, 2010, p. 7), recognizing that men and women "inhabit a world rife with contradictions and asymmetries of power and privilege" (McLaren, 2003, p. 193). It involves critically examining how ideas of masculinity and femininity are constructed, maintained, and upheld (Ringrose, 2007). It also aims to "expose how economic, cultural, social, and political systems intersect and operate, paying particular attention to the exploitative and oppressive relations that allow such systems to prosper" (Driessen, 2018, p. 25). My study does not provide an exhaustive analysis of the economic, cultural, social, and political systems and the interrelationship between all minority groups; to do so would require its own dissertation.

My inquiry is grounded in feminist theory and constructivist-interpretive theory within the context of women in mathematics education. The intersection of gender and sociocultural factors influences the decisions of women as they engage in the process of re-defining the relationship between their everyday view of femininity and mathematics education (Forgasz & Rivera, 2012, p. 65). Freire (1970) and hooks (2000) suggest that within rapid social change, there exists a deeply rooted desire to be good and to do good. In *Pedagogy of the Oppressed*,

Freire (1970) discusses the importance of problem-posing education, arguing that it affirms, "men and women as being in the process of becoming–as unfinished, uncompleted beings in and with a likewise unfinished reality" (p. 72). Freire (1970) believes that when learning is meaningful, learning is enhanced. When both educators and students are engaged in the learning process, students are more likely to persist. Research conducted by Dweck, Good and Rattan (2012) affirms that mindset about intelligence matters for women, suggesting that a growth mindset can buffer against adverse consequences for women believing false notions that suggest that math ability is fixed, and women have less fixed ability than men.

I believe that these ideas can be applied within the context of women in mathematics as a way of discovering different meanings that women ascribe to their experiences. By understanding one's social reality, knowledge has the potential to raise consciousness, which is foundational to action (Freire, 1970). Freire suggests that through *conscientização* (p. 61) (conscious raising education), understanding can be awakened, allowing the process of learning to move beyond engagement to retention, and to provide students with the opportunity to connect mathematics to themselves and the world around them. Understanding one's social reality through critical consciousness allows individuals to establish a sense of identity "as the power and oppression at play in society can either be affirmed or enforced in the learning experience" (Hunter, 2020, p. 12). Reviewing the literature on women in mathematics, Damarin (2008) argues that "through the discourse of mathematics education, 'woman' becomes (once again) [the] *other* to mathematics because 'gender and mathematics' and 'women and mathematics' are read and treated as equivalent" (p. 105). In addition, Erchick (1996) suggests that "women's and girls' mathematical opportunities or space are often framed in such a way that there are always already barriers to success" (Damarin, 2008, p. 105).

According to Adichie (2019), "gender matters everywhere in the world" (p. 10). Classical analysis of women's situation in society conducted by Simone de Beauvoir confirms that the "position of a woman in society is not the same as that of a man" (De Beauvoir, 1973, as cited in Yates, 2003, p. 6) and this notion continues to be relevant today. Critical feminist theorists such as Armenti (2004) suggest that institutions such as education "systemically advance the agenda of white males and oppress the lives of females by using subtle social and personal barriers preventing women from fitting in" (as cited in Giugno, 2015, p. 18). Simone De Beauvoir (1973) argues that men and women are educated differently from the outset stating that, "man learns his power" and women subtly and not so subtly, are conditioned to believe their inferior position. Furthermore, the claim that "women [are] not born fully formed" (Butler, 1986, p. 35) suggests that there are integral differences between men and women's situation in society. Ideals of femininity are constructed as women are socialized to believe that certain characteristics constitute a 'proper' woman. Therefore, feminist theory becomes a critical element to this research as I aim to understand how "gender as an aspect of identity, is acquired over time" (Butler, 1986, p. 35) given a women's experience—their situation—in mathematics.

An important aspect of narrative inquiry is sharing the lived experiences of participants in a meaningful way. Woodiwiss (2017) argues that we need "better stories around all aspects of women's lives" (p. 28) and suggests that researchers must be aware of the:

> dominance of certain narrative frameworks and storylines that are available to women, which they use to make sense of their lives and construct their own stories and guides for living, but which might constrain as well as liberate their possibilities. (p. 41)

In sharing a single story of one person without considering the situational element of gender, I risk a critical misunderstanding of their experience (Adichie, 2009). As a feminist, it is my

responsibility to ensure that my research explores "how and why some stories are told and not others, and why some stories can be and are heard and others silenced, or at times misrepresented" (Woodiwiss, 2017, p. 18). So as not to constrain my participants with a narrative framework that fit my agenda, I knew that my research must be *for* and *with* people, as opposed to *on* or *of* people. Sociologist and feminist Dorothy Smith (2005) uses feminist standpoint theory in her work which was later termed, sociology for the people. Feminist standpoint theory aims to:

> …create a point of entry into discovering the social that does not subordinate the knowing subject to objectified forms of knowledge of society or political economy. It is a method of inquiry that works from the actualities of people's everyday lives and experience to discover the social as it extends beyond experience. (Smith, 2005, p. 10).

I believe that Smith's work in combination with *conscientização* provides a solid framework to establish meaning from women's lived experiences in mathematics. Informed by feminist theory, my research considers ways to move beyond patriarchal ways of knowing, doing, and being, replacing our thinking with feminist thought and action (hooks, 2000).

Psychoanalytical Perspective

While developing my theoretical framework, I began reading the work of key theorists in the field of feminism which often inspired further analysis. For example, Judith Butler's theory of gender construction inspired my exploration of understanding relational ways of knowing, considering what might exist beyond interpretation, through the stories that women share about their experiences in mathematics (Stern et al., 1998). As my research progressed, I began to question how my participants constructed their identity within the context of mathematics, and I considered the statement provided by Britzman (2006):

> One of the oldest ideas … is the Socratic imperative "Know thyself." It is difficult to argue against this advice, for surely, we in education understand that our naked subjectivity is the only means we have to relate to others. Additionally, in thinking about the qualities of relations we make—what is to influence and to be influenced, what it means to care about something and recognize what the other cares about, and how our preconceptions of events may work as defenses against being affected—in all of these immaterial events, each individual learns of her or his knowing self. (p. xii)

Britzman's quotation urges me to consider the "naked" subjectivities that exist when sharing stories about lived experiences. It also challenges me to conceive alternative possibilities that may reside in our unconscious. In this research, I aim to understand the experiences of women in mathematics education, while identifying how their mathematical identities are shaped by societal expectations. The concern with examining one's subjectivity in relation to identity, is that it may privilege those who are emotionally unaware or unable to self-reflect (Ausman, 2018). However, the possibility of subjectivity within the socio-cultural context exists and can be examined once individuals are aware of it—the unconscious emerges into the conscious. In other words, this inquiry has the opportunity to explore women's unconscious views towards gender, power relations etc. that influence knowledge, while making these issues visible to the women who have experienced them.

Psychoanalysis challenged me to explore the unconscious perspectives of my participants and encouraged me to address fundamental ontological and epistemological questions, such as, "who are you?" and "what do you accept as truth?". In doing so, I reviewed psychoanalytical works of Sigmund Freud whose theory of the unconscious became a meaningful element of my research analysis. Freud's theory imparts that the mind is dual in nature and illustrates the

pervasive language that is used to describe human psychology. Freudian theory defines "irrational and unknown" thoughts within the unconscious as the *id,* and "rational, logical and ordered" thoughts within the conscious as the *ego* (Ausman, 2018, p. 51). Freudian theory is fascinating in combination with critical feminist theory as it discloses the ways in which our sense of self is "influenced by unconscious drives and ordered by symbolic structures that are beyond the purview of individual agency" (Zakin, 2011, para. 2). It is important to note that "psychoanalysis does not try to describe what a woman is—that would be a task it could scarcely perform—but sets about enquiring how she comes into being" (Freud, 1968, p. 116).

Social Constructivist Theory

Social constructivists believe that "what people know and believe true about the world is constructed—or made up—as people interact with one another over time in specific social settings" (LeCompte & Schensul, 1999, as cited in Schram, 2006, p. 44). Social constructivist theory seeks to understand the social world and the interpretations that people make of it. As such, this study aimed to understand the complex and constructed reality from women's point of view based on their experiences of participating in mathematics.

This study is informed by social constructivist theory, and I draw from the work of John Dewey (1938) who argues that although learning is a result of experience, not all experiences are "genuinely or equally educative" (p. 25). Dewey (1938) further explains that education is not void of experience, but rather the context of experience can "prevent a person from getting out of them what they have to give" (p. 26). This is particularly relevant in understanding women's experiences in mathematics considering that they may have different experiences to men that hinder their participation. From a social constructivist perspective, mathematics is an intimate

arena for reality construction as women negotiate and redefine their past and present experiences to create new relational meaning. Indeed, qualitative research provides various ways of conducting data collection however, narrative inquiry was selected for this study given its intimate approach to understanding lived experiences through the passage of time and the emphasis on the construction of stories and the meaning that is found within.

Definitions

Mathematics Education

Mathematics education is defined more broadly as the relationship between human beings and mathematics, in their entirety. It accepts the notion that "one must study and investigate mathematics as it is currently practiced, produced and used in all its forms" (Dörfler, 2003, p. 149). It recognizes that a dialogue cannot exist about mathematics with the exclusion of mathematics activities, or the human beings involved.

Participation

Accepting the view that mathematics education and all its facets are to be studied in their entirety, participation refers to how a woman's presence in mathematics is determined by cultural and functional factors (Lancaster, 2013). In this sense, participation is considered a fluid notion, and can be described by Dahlgren (2018) who said that:

> Power relations and structures refer not only to such obvious manifestations…but also to cultural and discursive forms…power involves both 'power to' (enabling) as well as 'power over', in the form of coercion, constraint, or influence. Thus, participation in itself is an expression of some degree of (enabled) power. (p. 8)

Critical Moments

Critical moments consist of events where pivotal decisions are made. They are key to understanding one's pathway, identities, choices, and concepts in life. Recognizing critical moments requires mindful awareness of the self; an acknowledgement of the social and contextual elements that occur within the space.

Mathematics Culture

Mathematics Culture is defined here as an "integrated system of collective mathematical knowledge transmitted among groups" (Gilmer, 1998, p. 3). It is not static. Individuals experience its application within the context it is applied. It evolves and responds to shifting environments and circumstances.

Narrative Inquiry

Narrative inquiry is a form of qualitative research that gathers data (narratives) that focus on the meaning participants associate with and ascribe to a particular experience (Trahar, 2009). It is understood as "a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected" (Czarniawska, 2004, p. 17). Locating events and ideas in time and place is important to this study as it aids in understanding women's experiences within a particular space, during similar stages in life, regardless of individual circumstances.

Significance of the Inquiry

Mathematics education belongs to two very distinct domains of mathematics and education, each with competing ideas of the purpose of mathematics and who can "do" mathematics. Misconceptions, including faulty images of what it means to be a woman in mathematics, are likely to discourage women from engaging in mathematics study, thereby limiting future opportunities in fields that require these skills. Without mathematics literacy, and

a strong mathematics identity and sense of agency, women will increasingly find it difficult to challenge many of the decisions and actions of those in power (Larson, 2018, para. 11).

Concluding Remarks

The false perception of mathematics is that it is disconnected from all other academic disciplines or real-world-problems (Sleeter, 1997) and the academic literature confirms that the construction of individual perceptions of mathematics "threatens both achievement and participation" (Hembree, 1990, p. 34). Avoidance of mathematics results in capable individuals limiting opportunities ranging from career choices to fundamental skills that are required in the 21st century—such as problem solving, reasoning, decision-making, and critical thinking. While the value of women in mathematics fields has been viewed as an opportunity to change or improve practices, the notion of "women's abilities" is problematic. Gendering the value of "women's skills" in mathematics suggests that they are incapable of doing what males have been doing all along. It is far more productive to inquire about women's experience with learning mathematics and understand the influence that it has on their participation in various fields that require considerable knowledge of mathematics.

The following chapter provides an overview of the literature pertaining to women's participation in mathematics and mathematics education. The chapter is divided into four sections following the introductory paragraph. First, the contextualization of mathematics education within Ontario is examined from a historical perspective. Second, the various factors that influence women's participation in mathematics will be reviewed. Third, the various transition points across pathways to participation are considered. Finally, the cultural complexities of gender and the constructions of women's identity are explored.

Chapter Two

Literature Review: Pathway to Participation in Mathematics Education

"In a truly equitable system, factors such as race, gender, and socio-economic status do not prevent students from achieving ambitious outcomes"

—Ministry of Education, (2008), p. 8

Preamble

Improving the participation of women in mathematics within Canada is a complex and multifaceted issue. The educational literature presents a hazy picture of the underrepresentation of women, involving competing notions of biological and sociocultural causation (Ceci et al., 2009). The inclusion of women in mathematics fields is steadily increasing as the demand for innovation, technological advancements and economic competitiveness is on the rise (Ong et al., 2011). Statistics demonstrate that despite the increasing number of women's representation in mathematics (40% at the bachelor's and master's level in 2014), the proportion of women continues to decline (National Science Foundation, 2017). Some researchers argue that economic vitality depends on the untapped resource of women sharing their diverse backgrounds, perspectives and experiences as they contribute to scientific discovery and innovation (CEOSE, 2009 and forthcoming; National Academies 2010a, 2010b) and help to solve the complex technological problems of our time (ACGPA, 2009; Bement, 2009). The need for mathematical competency extends far beyond Canada's rank on a global economic scale and impacts the most fundamental quality of life for all citizens.

Prior to reviewing the literature relevant to the research questions, it is important to first situate mathematics education within the historical context of Canada and define mathematics education as it pertains to this inquiry.

Contextualizing Mathematics Education

During the 20th century, Canada experienced immense growth in the area of mathematics education, both in the number of doctorates awarded as well as in the number of researchers entering the field of study (Kieran, 2002). This strong period of growth continued from post WWII until the 1970's, as teacher education transitioned from college to university and the potential for funding opportunities increased given the number of doctorates awarded and potential research funding opportunities provided (Kieran, 2002). Towards the latter half of the decade, communities of practice started to emerge and new platforms for participation developed across mathematics education. These communities of practice are considered distinct groupings—such as researchers, teacher educators, mathematicians—but it's often challenging to disentangle them. According to Wenger (1998):

> We all belong to communities of practice. At home, at work, at school, in our hobbies—we belong to several communities of practice at any given time. And the communities of practice to which we belong change over the course of our lives. In fact, communities of practice are everywhere. ... In laboratories, scientists correspond with colleagues, near and far, in order to advance their inquiries. Across a worldwide web of computers, people congregate in virtual spaces and develop shared ways of pursuing their common interests. We can all construct a fairly good picture of the communities of practice we belong to now, those we belonged to in the past, and those we would like to belong to in the future. We also have a fairly good idea of who belongs to our communities of practice and why, even though membership is rarely made explicit on a roster or a checklist of qualifying criteria. Furthermore, we can probably distinguish a few communities of practice in

> which we are core members from a larger number of communities in which we have a more peripheral kind of membership. (p. 6–7)

The intersection between mathematics and mathematics education has a great influence on women's participation and yet, there is little research on the relationship between the two communities as it relates to women specifically. There are many, perhaps even mutually exclusive, standpoints on what mathematics education is, and who should do it. For example, mathematics educators and mathematicians consist of members from two very distinct groups and they "differ in the types of knowledge they produce as well as ways of pursuing that knowledge" (Goos, 2018, p. 9). Metaphorically, mathematics education is "the study of relationships between mathematics and human beings, both taken in their whole variety" (Dörfler, 2003, p. 147). In his meta-study of mathematics, Dörfler (2003) argues:

> The general tenant of mathematics education is to study and investigate mathematics as it is currently practiced, produced and used in all its forms. In this sense, mathematics education has to be interested in the early counting activities of children as well as the production of a proof in analytic number theory. Acceptance of this description of mathematics education clearly leads to attributing to mathematics a very special role for mathematics education as a scientific discipline. Very likely, the case is different for the role (professional) mathematicians currently take in relation to mathematics education. (p. 147).

Proulx and Simmt (2011) argue that "the compartmentalization of mathematics from mathematics education courses is historical and conjectures that it may in fact be a detriment to teacher education" (p. 411). Understanding how mathematics educators participate in the critical

discourse of mathematics is important and requires a deeper analysis of how these two fields are related as communities of professional practice, and how societal boundaries define them.

Connecting Women with Mathematics

Improving the participation of women in mathematics education is worthy of exploration, not least, because it enhances the awareness of equity in education and contributes to making mathematics more accessible to all. Women's participation in mathematics is influenced by a myriad of factors, both internal and external to the individual. Internal factors are considered the individual beliefs that influence behaviour and actions in a person while external factors are the influences, circumstances and situations that affect the outcome of an experience. Although these factors exist, they are not mutually exclusive, and there is much distinction in relation to the individual interpretation. For instance, literature pertaining to women and mathematics has refuted the pervasive myth that women are underrepresented due to their lack of interest (Boaler & Sengupta-Irving, 2006; Hanna, 2003, Leder, 1992). In this example, interest is the internal factor, but it cannot be assumed that it is the sole detriment to participation in mathematics. Further investigations are needed to determine how women's pathways to participation are constructed to better understand the influence that internal and external factors have on shaping these experiences.

Internal Locus of Control

To better understand the significance of internal factors on women's participation in mathematics, this thesis will examine the key concepts of self-efficacy and anxiety. Internal locus of control refers to an individual's belief system. While there are many internal aspects—such as determination, fear of success, attributions, and persistence—that influence and discourage participation in mathematics, the disparities between the two are widespread among

individuals. They are also informed by our experiences, our connections with others and are self-reinforcing. The goal then, is not to provide an overview of every possibility, but rather discuss two characteristics that commonly relate to women's participation in mathematics.

A large body of research pertaining to participation was conducted in the 1980s and 1990s, generally concluding that women's participation could be blamed on a women's lack of confidence, as well as the belief that math was hard for girls (Hyde et al., 1990; Jones, 1989). Early research tended to focus on biological explanations for perceived differences while others examined issues that might affect women's experience in mathematics (Hall, 2012). More recent research has affirmed that of all the variables influencing women's participation, "no evidence has been found for mechanism based on biological influence" (Grevholm, 2007, p. 617), confirming that the intersection of gender and ability is irrelevant (Fennema & Sherman, 1977; Hango, 2013). Yet, how individuals perceive their abilities in the area of mathematics differs between women and men. For example, women tend to underestimate their mathematical ability, while men overestimate their mathematical ability (Ellis et al., 2016; Hango, 2013; Herbert & Stipek, 2005). This leads to a discussion about how women view themselves in mathematics and how perceived barriers impact their decision to continue engaging in mathematics.

Self-Efficacy.

In the context of mathematics, self-efficacy can be described as the perceived confidence in one's ability to "perform well with regard to particular mathematical tasks or in particular math or math-related courses" (Hackett, 1985, p. 48). A review of women's participation rates in mathematics suggests that self-efficacy is a key indicator of women's involvement in mathematics (Ceci et al., 2009; Hackett, 1985; Multon et al., 1991; Pajares & Miller, 1994). More specifically, the literature notes that there are significant "gender-related differences in

efficacy expectations, particularly lower-self efficacy expectations on the part of the women" (Hackett, 1985, p. 47). Women's lack of confidence in mathematics is further sustained by "societal attitudes and biases that reinforce erroneous beliefs of gender differences in intellectual abilities" (LeBlanc, 2015, para. 5). This suggests that interpretations on what women can and cannot do in mathematics need to be re-visioned, that they are no longer supportive of inherent biases, and are conscious of the myths and misconceptions that suggest "girls can't do math".

Anxiety.

According to researchers of mathematics education, there are various ways to define mathematics anxiety. Trujillo and Hadfield (1999) describe mathematics anxiety as "a state of discomfort that occurs in response to situations involving mathematical tasks that are perceived as threatening to self-esteem" (p. 173). Other researchers argue that mathematics anxiety is a result of a psychological reaction contributing to their lack of confidence in mathematics (Hembree, 1990; Luo et al., 2009). Additional studies confirm that math confidence and math anxiety are highly interdependent and can negatively impact academic performance (Fennema, 1980; Hendel, 1980). When anxiety in mathematics increases, women tend to disengage which perpetuates the fear and reinforces the anxiety (McGlynn-Stewart, 2010).

Much of the literature identifies anxiety as a significant barrier to women's participation in mathematics. Some researchers even go as far as blaming anxiety for lower participation of women in high school and college level mathematics (Meece et al., 1982; Tobias, 1980). The crippling fear of embarrassment, shame, judgement, and lack of competency can have crucial impacts on students' learning experiences. Arguably, this is not a result of *math* anxiety but rather anxiety based on negative experiences in education. Research in mathematics education reveals that individuals' experiences with mathematics shape how they think about doing

mathematics (Ball, 1988; Mizala et al., 2015; Swars et al., 2006). For example, a student who is not given the opportunity to make mistakes in mathematics might experience more pressure to have the correct answer all the time. Similarly, the inability to understand a word problem may result in an incorrect answer, but it doesn't reflect the ability of the individual to solve the mathematical problem. When individuals are not provided with opportunities to identify ways of knowing and understanding mathematics, they become less likely to believe false notions such as, not being good in math. This is particularly true for women, as anxiety appears consistently higher than that of males (Betz, 1978).

External Factors

Mathematics education is considered a social activity, one that human beings participate in within the social setting of schools. The educational relationships that develop in school influence participation from a social, cultural and political perspective. From a very young age, women and girls receive overt and subtle messages about their ability in mathematics. These messages are further reinforced as women who identify as being feminine appear to be at odds with identifying as a professional in STEM fields (Pronin et al., 2003). In her study, Ingram (2013) highlights the effect of the hidden curriculum, the "implicit messages sent to students from the actions and behaviour of their teachers and school staff that legitimize dominant social values that extend well beyond the stated curriculum" (p. 18). Schools often inadvertently produce attitudes and gender biases within and across student groups and between adults and students which leads to a discussion on the external factors and how they influence women's participation in mathematics.

Peer Influence.

Achievement (or academic success) is often viewed as a result of the belief in one's capability, as well as the quality of school experiences and social interactions. The attitudes and expectations of others greatly influence students' decisions to pursue particular interests (Pelletier, 2006). A study conducted by Becker and Jacobs (1993) concludes that "males and females are influenced by different societal expectations, and although students receive the same formal mathematical study, they encounter different learning experiences" (p. 61). There is a growing self-consciousness in girls that is further intensified by peer pressure and the need to conform (James, 2009). The mathematics classroom, therefore, becomes a "political arena where ideological and moral discourses compete against one another and individual and collective identities are constantly being negotiated and reconstructed" (Lim, 2012, p. 81). As girls mature, gender tends to play a greater role in attitudes and beliefs towards mathematics. Research shows that girls whose friends conveyed support for mathematic pursuits, along with gender-egalitarian beliefs, were more motivated to pursue STEM topics than those whose friends endorsed gender typical roles (Leaper et al., 2011). Establishing positive relationships among students therefore becomes crucial in a classroom that aims to support equitable learning. When educators create environments that support caring relationships, it then becomes possible to "disrupt negative messages and beliefs about self-worth and success" (Hurlington, 2018, p. 239). Equally important, is the way in which educators facilitate these interactions so that women have opportunities to work within the range of their multifaceted identities, knowing that they will be supported by their peers.

Family Support.

Research indicates that parents have a significant role in influencing children's participation in mathematics as they are often exposed to mathematical concepts before they enter the school system (Starkey et al., 2004). The mathematical knowledge that students enter the classroom with appears to have an impact on their academic achievement in later years (Lee & Burkham, 2002). Conversations about numbers (number talk) for example, has been found to influence children's understanding of the cardinal meanings of numbers from a very early age (Levine et al., 2010). Potential gender norms that exist within the household may put girls at a disadvantage when it comes to mathematics. For example, mothers' beliefs about gender and the associated expectations have been shown to strongly predict their children's careers (Chhin et al., 2008). In addition, parents' beliefs about their children's capabilities are important indicators of their success in school. Bleeker and Jacobs (2004) found that a mother's influence was particularly strong as they reported lower expectations of their daughter's capacity for success in STEM than the mothers of boys.

Mentors and Role Models.

The perception of women in mathematics directly impacts their performance, as girls become aware of the subtle and overt cultural messages of male superiority. Teachers, mentors and role models can inadvertently contribute to these perceptions through passing on their gender biases and preconceived notions of ability. Teachers, for example, maintain ideas about how they should be treated by students and inversely how students should be treated by them, combined with factors influencing their personal identity, which may impact how they motivate students to learn. Understanding the relationship between students' expectations and predispositions is important when teaching mathematics (Boaler, 2002). Bannier (2017) noted that "critically

thinking about the use of language in mathematics and encouraging writing can enhance the experience of female learners" (p. 23). Practical applications of mathematics that value diversity allow women to identify with accurate representations of their personal experiences. One study found that images can subconsciously trigger self-doubt in girls stating, "when school students viewed chemistry textbooks containing pictures of female scientists, they performed better than female students who viewed textbooks containing only pictures of males" (Berwick, 2019, para. 11).

Individuals in a position of influence communicate messages about their own attitudes and therefore have significant impacts on student success. One study of elementary students showed a relationship between the teachers' anxiety towards teaching mathematics and students math scores (Beilock et.al., 2010). Specifically, teachers with higher anxiety were found to be positively correlated with female students' beliefs in traditional gender abilities. When gender typed thinking was applied, girls achieved lower scores on the math assessment. Additionally, Tiedemann (2000) found that teacher expectations were amplified by parental beliefs stating that "mothers and fathers, on average, believed that boys were more competent in mathematics than were girls; the children's teachers also perceived boys to have more ability in math than girls, despite the fact that there were no significant differences between the boys' and girls' previous or current grades" (p. 146).

Closing Remarks

Mathematics education by its very nature, is the process of transmitting highly valued knowledge. Valero (2007) claims that the "transformation of knowledge from one field of practice to another field of practice, helps regulate the action of students, their thinking frames and their possibilities of participation and exclusion from participation in the social world" (p.

10). Therefore, mathematics education plays a large role in determining what is valued in society. He further argues that transformation of power "does not happen directly as a consequence of open struggle and resistance, but through the participation of actors in social practices and in the construction of discourses" (Valero, 2007, p. 11). By this definition, the influence of peers, family, and mentors affirm discourses and affects the perspectives of women and their participation in mathematics.

The Undivided Self

"Women are not born, they are made"

—Simone de Beauvoir

Today, mathematics education is regarded as more than a collection of abstract concepts and fundamental skills that need to be perfected. It reaches beyond the physical sciences, placing more emphasis on the mathematics community—in the language we use, the preconceptions we own, and the values and experiences that we bring into the classroom. In this context, we can think of "mathematics culture" as acquired knowledge transmitted among groups (Gilmer, 1998, p. 3). Thus, the values and beliefs seen in what people do, what they know, and the tools they use, support in the construction of knowledge in mathematics. This is important for women in particular, as research has shown that the "development of an individual's positive or negative identity in the domain of mathematics is a subtle and complex process" (Lim, 2012, p. 64).

The Role of Gender in Mathematics

Gender values and norms are embedded so deeply in our institutions, our actions, and our beliefs that they seem natural and predetermined. Ideas of gender are commonly accepted as obvious truth, and these norms have grave consequences for women's participation particularly in domains that are perceived to be male dominated. Jacobs (2010) argues that "gender is not a

salient variable" meaning that males and females have value systems that operate in their cultures differently (p. 435). Therefore, gender is social not biological. It is not something that individuals are born with or have but rather, something they do (West & Zimmerman, 1987)—something they perform (Butler, 1990). It is so intricately organized at every level of experience that it heavily influences individuals' perceptions, reactions and interpretations of others and themselves.

Despite best efforts, the educational system in Canadian continues to reproduce "heteronormative, traditional notions of femininity and gender roles" that result in the minimalization of the lives and contributions of women (Ingram, 2013, p. 15). Ingram (2013) states that "for many girls, schooling is a subtractive process where girls learn to repress, hide, deny parts of their identity and privilege others" (p. 20). In a sense, schooling forces women to construct their identity within a "matrix of domination and they are socialized in ways that undermine their self-esteem, encouraging them to defer to existing hierarchies" (Ingram, 2013, p. 20). Eckert et al. (2013) suggests that women learn ways to participate, stating:

> Habits, preferences, and beliefs develop in response to experience, and to the extent that the social order structures our experience, there are likely to be patterns to who develops what. This does not mean that women or men are homogeneous groups: some men may cry readily; some women may never shed tears. Not everyone adopts the dominant script. How we develop, however, is never a matter of the straightforward unfolding of individual dispositions but always reflects exposure to norms, expectations, and opportunities that depend on gender and other social categories (p. 18).

A prominent concern that arises from exploring the role of gender in mathematics is the hierarchical structure of education and its effects on status of achievement. One of the major

tenets of Women's Studies involves eliminating hierarchies and supporting the empowerment of women and yet many public spheres such as mathematics, hold greater power and prestige than others. Mathematics is considered an integral subject in education which tends to have better access to funding for mathematical resources and initiatives. Moreover, being proficient in mathematical literacy opens the door for future opportunities. Sleeter (1997) views mathematics as a "critical filter" for universities and to many fields of study and careers (p. 683). To some extent, "[individuals] who succeed in mathematics gain entry into a wider society where status and power reside" (Sleeter, 1997, p. 687). This division of labour can also be seen as "a division of value" which results in a gendered division of power and status (Eckert et al., 2013, p. 24). In contrast, lack of success in mathematics can be seen as a form of exclusion. Mathematics is a social activity and women are often left out of male social groups which naturally affects their "access to collaboration" including their mathematical careers as well as their self-images (Henrion, 1997, p. 961). If women are consistently socialized to believe that mathematics is a male domain, they will in turn feel less motivated about participating in mathematics.

Constructing Identity

Researchers in mathematics education are increasingly studying how constructs of identity shape individual perceptions of their experiences. Identity holds various meanings, but it is mostly agreed upon that identity "provides a link between individuals and the world in which they live" (Woodward, 2004, p. 7). The literature on identity in mathematics education distinguishes between learner identities and teacher identities, suggesting that there are separate entry points for discussion (Darragh & Radovic, 2019; Graven & Lerman, 2019). The literature is also consistent in noting the importance of socio-cultural impact on one's identity (Darragh,

2016). The leading critique of identity research is that it often lacks context which leads to ambiguity (Brubaker & Cooper, 2000).

From a theoretical perspective, mathematics education research tends to rely on the "median" approach, a social concept developed by sociologist, George Herbert Mead. The "median" identity is often associated with the individual and their social environment. It acknowledges that humans have multiple, perhaps even conflicting identities, that are constantly adapting to the social contexts in which individuals are placed. Schools are social settings and therefore play a large role in identity development. The social interactions that take place within the educational system are constantly sending signals that define who we are and who we want to be. Perceptions of our identity are shaped by how others view us and how we want to be viewed, and these views may not always align. Women's identity in mathematics is often shaped by their existing notions of femininity and how they perceive their own learning abilities. Moreover, identities and agency of students are often ignored when examining gaps in academic achievement. Drawing comparisons between different groups of students puts them in opposition of one another and creates "an unintended message that marginalized students are not worth studying in their own right – that a comparison group is necessary" (Caswell, 2011, p. 359). This binary construction is prevalent in research related to women's achievement in mathematics as men often become the comparison group.

Research in mathematics education has shown that academic achievement depends on much more than the knowledge of requisite mathematical content. Knowing computational procedures, algorithms and facts are not predeterminants of student success. The beliefs one holds relevant to their performance in mathematics influences the direction and outcomes of their academic achievement. It is important to note that beliefs exist based on thoughts that are

validated, affirmed, and accepted by other thoughts. They are generalizations that evolve from experiences and understandings, and they differ from thoughts in the sense that we can think without believing. For example, women may not *believe* that they are inferior to men when it comes to ability in mathematics, however, they may *think* that they are. The idea that women's ability in mathematics is inferior to men only becomes a belief when their thoughts are validated and accepted as truth. Beliefs can be seen as realistic conclusions based on student observations and perceptions. Structurally, beliefs are grounded in social life and determined by the broader context in which individuals are situated.

Concluding Thoughts

In mathematics education, it seems that there is a culture of disconnection and one that elevates intellectual virtue. Polarities exist between communities of practice and the subtle distortions of gender may make it difficult for women to create a sense of belonging without it being dependent on others. Ingram (2013) suggests that the "socialization of ideas about gender reinforces the notion that any different patterns of participation can be attributed to biological sex differences and not socially constructed notions of appropriate behaviour and roles for men and women" (Ingram, 2013, p. 43). Understanding the complexities of identity allows researchers to examine women's experience in mathematics from a holistic lens, in relation to the social context. Palmer (2017) beautifully explains the importance of acknowledging all aspects of identity and suggests that the paradoxical joining of apparent opposites is in fact what leads us to the profound truth. In this sense, a women's positionality in the field of mathematics depends on their ability to stand firmly at the intersection of their identity, recognizing all it encompasses.

Transitions Along Pathways: Being, Becoming and Belonging

"Statistics do not talk; however, they only point us to whom we need to talk about"

—*Stepp, 2007, p. 8*

Considerations of gender are particularly relevant in mathematics education. In many developed countries, including Canada, perceptions of gender inequities are often considered an issue of the past, one that is thought to have been resolved. In reality, gender inequities still exist, and the gap in mathematics is particularly wide in terms of women's participation. An analysis of the magnitude of gender inequities in mathematics during specific moments in time, can help pinpoint barriers within the educational system. Mathematics education in Canada is a provincial responsibility therefore, it is not consistent across the country. As such, enrollment trends in Ontario's education system will be explored to identify patterns of women's participation at various points in time. Ontario was selected for review as it is the most populous province, comprising 38% of the nation's population and provides a strong representation of the entire country (Statistics Canada, 2021a).

Representation in Canada's Education System

The educational system in Ontario consists of nine years of compulsory schooling (Elementary) where all students are exposed to the same learning outcomes from the Ontario Mathematics Curriculum. Part of Ontario's commitment to student success in mathematics is reporting conducted by the Educational, Quality, and Accountability Office (EQAO). Canada also participates in international assessments, such as the Program for International Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS). However, the international assessments results will not be discussed here, given the Canadian context of this inquiry.

The Ontario Ministry of Education (2020) outlines a vision for learning mathematics that encourages educators to place more emphasis on the learning process rather than performance, as a way of positively influencing students' attitudes towards learning mathematics. Although large-scale assessments report on the effectiveness of Ontario's education system in particular subject areas, evidence suggests that it is in need of a grand overhaul for numerous reasons (Després et al., 2013). A primary concern with the analysis of academic achievement in mathematics is that it tends to rely heavily on standards-based test results as valid measures of student capability. The argument suggests that provincial assessments create a gap between what is tested and the broader set of educational objectives. Large-scale assessments are criticized for emphasizing a limited set of functional knowledge and skills as opposed to assessing the acquisition of knowledge, skills, or other cognitive abilities such as, problem-solving and critical thinking (Després et al., 2013). Educators have long disputed the significant amount of time that is spent in preparation for the assessment and suggest that students are negatively impacted by the strong focus on specific outcomes. The Ontario Teachers' Federation describes this as a "difference between instruction for improving student learning and instruction for improving student test scores" (Ontario Teachers Federation, 2011, p. 7). The number of assessments has been questioned as a limited sample size may reflect inaccurate representations of students' capabilities (Després et al., 2013). The concern with a limited sample size is that it does not take into account the many factors beyond the classroom that may impact students' ability to perform on any given day. The Royal Commission on Learning has recognised, "frequent and cumulative assessments that occur daily have much greater potential to increase and enhance learning relative to large-scale standardized testing" (Royal Commission on Learning, 1994, p. 6). Consequently, the pressure within the classroom to learn math in a way that is consistent with

standard based tests may limit women's participation and interfere with their ability to see themselves as competent math learners based the notion of performativity.

Upon completion of elementary school, most students transition into secondary school where they are required to complete three compulsory mathematics courses. In Ontario, at the time of this study, there are three streams (pathways) for mathematics education at the Secondary level: locally developed courses, applied courses and academic courses; each pathway determining a future destination. Academic streaming or tracking refers to "the practice of assigning students to instructional groups on the basis of ability" (Hallinan, 1994, p. 1). Streaming in secondary school remains a controversial topic in Ontario's education system as there is great debate over the effectiveness of student success when placed in a specific stream. In response to available research on student outcomes, the Ontario government has stated that academic streaming will be pushed back to Grade 10 in September 2021 (McQuigge, 2020). Research supporting the change to academic streaming indicates that twice as many students are successful in the academic pathway in relation to the provincial assessment scores, with only 16% of students failing to reach the "academic standard" (Macaulay, n.d., p. 5). In contrast, 60% of students in the applied stream are not reaching the academic standard (Macaulay, n.d., p. 5).

Secondary school mathematics is considered a critical filter that affects women's participation in higher education and future career opportunities. Secondary school is a transformative time for many students as they learn to navigate societal expectations while being urged to decide on pathways that impact their future. One study conducted by the OECD (2017) found that "career paths of girls and boys start to diverge by the age of 15" (p. 24), around the same time that streaming decisions are made. The trend of less women showing interest in mathematics courses continues into higher education with only 37% of women currently

participating at the university level, in fields of Science, Technology, Engineering and Mathematics (Statistics Canada, 2021b). Although women's representation is higher than their male counterparts at master's level of education—36, 030 women enrolled as of 2015 compared to 25, 910 men—there is still a very low number of women entering doctoral studies in mathematics (Statistics Canada, 2020). Research on women in academia illuminates critical issues in gender equity, indicating that women are more prone to socio-cultural barriers thus limiting their participation even further (Social Science Feminist Network Research Interest Group, 2017). The following section provides an overview of the patterns in women's representation starting from their earliest experience in elementary school to a potential career in academia. Statistics at each transition aim to provide key insights on women's participation in Canada's education system, but they are in no way reflective of individual experiences.

Earliest Experience in Elementary School

Encouraging students to become active participants of society is a common goal shared by many educators in Ontario, and it requires students to develop a multitude of literacy and numeracy skills. All elementary schools follow the same curriculum as determined by the Ministry of Education which provides equal opportunity and access to education for all students. To assess students' understanding, EQAO has created large-scale mathematics assessments that are administered on an annual basis and students are required to participate in them at three points during their education: Grade 3, Grade 6 and Grade 9. The assessments consist of both (open) short and long answer questions and (closed) multiple choice questions that are evaluated using a leveled scale. The leveled system is aligned with the four-level scale developed by the Ministry of Education and used on the Provincial Report Card. As of 2019, EQAO expanded its reporting measures and pre-service teachers are now required to complete the Mathematics

Proficiency Test (MPT) to assess mathematical competency, as mandated by the Ontario College of Teachers. To better understand women's participation in mathematics at the elementary level, an analysis of EQAO results will follow.

During the 2018-2019 school year, the percentage of students in the primary division (Grade 3) who met or exceeded the provincial standard in mathematics was 58% (57% girls and 60% boys), compared to the junior division (Grade 6) at 48% (48% girls and 48% boys) (EQAO, 2020a). Results in achievement reveal that girls perform relatively at the same level as boys in elementary school. Differences were noted in self-efficacy, motivation, and confidence where 51% of girls in Grade 3 reported that they liked math compared with 62% of boys (Freedman, 2020). As students mature, data reveals that 41% of girls stated that they enjoyed math compared to 58% of boys in grade 6 (Freedman, 2020). Additionally, for both primary and junior divisions, "basic knowledge of fundamental math skills is stronger than their ability to apply those skills to a problem or think critically to determine an answer" (EQAO, 2020b, "EQAO Assessment Data" section).

Transitioning into Secondary School

The transition between elementary school and secondary school has been recognized as a pivotal moment for students with a noticeable dip in academic achievement, self-confidence, and increased social anxiety (Alspaugh, 1998; Eccles, 1993; Galton, 2003). To receive their Ontario Secondary School Diploma, students are required to obtain three mathematical credits, including one credit in Grade 11 or 12. Given that many students opt to fulfill their math credit in Grade 11, the proportion of mathematics on their course load is not a significant indicator of their participation in mathematics. The focus on senior level mathematics (Grade 12) provides a better indication of women's participation as these courses are often considered electives. Six courses

are provided at the Grade 12 level including three university preparation courses, two college preparation courses and one workplace preparation course (Ministry of Education, 2007). Research indicates that women in Grade 12 represent a lower percentage of students participating in mathematics courses when compared to their male counterparts. One course, Mathematics of Data Management, indicates that women are represented higher than males (51%>49%), however, it is not recognized as a required course for entrance to university (Hall, 2012, p. 68).

Although women's participation in mathematics may seem problematic, EQAO results indicate that there is very minimal gender difference in achievement with 41% of women in the applied stream meeting the provincial standard, compared to 47% of males. More promising, is that both genders (84%) are meeting the provincial standard in the academic stream indicating that streaming may be to blame for lower participation in general. Additionally, research conducted by EQAO (2020c) states:

> One-third of Grade 9 students enrolled in the applied mathematics course like mathematics (35%) and a similar percentage see themselves as good at mathematics (32%), while more than half of Grade 9 students enrolled in the academic mathematics course like mathematics (57%) and a similar percentage see themselves as good at mathematics (54%). Grade 9 students enrolled in the academic course have significantly higher perceived self-efficacy in mathematics than students enrolled in the applied course. (para. 2)

EQAO results suggest that a lower percentage of students enjoy mathematics and see themselves as doing well in mathematics in the applied stream when compared to that of the academic stream. It is then unsurprising that academic students would have a higher perceived self-efficacy

in mathematics given the fact that they tend to enjoy the subject. Given the importance of secondary education and the impact it has on future participation in mathematics, it is critical for Ontario to promote a system that supports educational opportunity, academic achievement, and student success across all levels of mathematics.

Access to Higher Education

Student enrolment in university programs is increasing steadily as Canada's knowledge-based economy continues to experience rapid growth (Statistics Canada, 2018). The number of enrolments in mathematics, computer and information science programs demonstrated the strongest growth (+102.7%), with the "number of students increasing from 47, 748 in 2008/ 2009 to 96, 768 in 2018/2019" (Statistics Canada, 2020, para. 9). Since 1990, women have represented the majority (56%) of enrolments in Canada's public colleges and universities, but they consistently represent a minority in mathematics fields (Statistics Canada, 2016). A study conducted in 2013, showed that "men were twice as likely to pursue STEM programs" in university" (Statistics Canada, 2019a). Problematically, women with a higher level of STEM credentials were less likely to pursue STEM occupations compared to their male counterparts (Statistics Canada, 2019b, "Executive Summary" section, para. 5). Although women are increasingly participating in higher education in general, a large gap remains in the area of mathematics. As of 2019, the percentage of women entering STEM programs at the post-secondary level was 37.9% (Statistics Canada, 2021). The data indicates that women are more likely to enter fields such as health care where there is 77.6% enrolment and education with 77.5% enrolment (Statistics Canada, 2021b). Although women make up the majority of workers in education related occupations, there is limited research on how many women are participating in mathematics education at the post-secondary level. A possible explanation for this might be

because higher education does not categorize degrees by subject topics. Rather, the overarching theme of cognition and learning is recognized as an example. When examining the educational choices of female students beyond high school, Pellitier (2006) found that "only 21% of women with strong mathematics backgrounds planned to pursue a university education in mathematics" (p. 53) and noted that this was partly a result of "direct encouragement from teachers, had working mothers as role models, and parents with higher education and occupational levels" (p. 55). This study also indicated that women's mindset towards mathematics is equally important, stating:

> The females pursuing mathematics said that mathematics made sense, that it was challenging, fun and that they loved numbers. Those females not pursuing mathematics stated that they did not feel comfortable with mathematics, that it was boring despite high achievement levels and further, that they did not see the relevance of mathematics and had taken it only because it was a requirement. (Pellitier, 2006, p. 55–56)

Among the women who enter STEM, 66% remain after the first year compared to 72% of males (Wall, 2019). The low persistence rate can be attributed to the fact that women are twice as likely to switch from STEM to BHASE, indicating a switch into the field of health care (Wall, 2019).

At the university level, the proportion of women in the field of mathematics shows a decline in participation from 35.2% in 1992 to 30.4% in 2008 (Statistics Canada, 2015, Table 9). Similarly, the proportion of women in the field of mathematics has decreased from 50.6% in 1992 to 43.5% in 2007 at the master's level of education (Statistics Canada, 2015, chart 8). In contrast, the number of women entering a doctoral program in the field of mathematics has increased from 32% in 1992 to 44% 2008 (Statistics Canada, 2015, Table 13). The statistics

affirm a sharp contrast in women's participation in higher education studies and their lack of engagement in mathematics fields.

Mathematics Educators

Hersh and John-Steiner (2010) conclude that "throughout most of history, the world of mathematics has been separated from the broader cultural milieu" (p. 68). Over time, women have increasingly participated in higher levels of education and subsequently increased their representation in the workforce (Women in the Workforce, 2020). They have maintained their status as the majority of workers in education-related occupations (Statistics Canada, 2015, Table 9) and account for 39% of university professors in Canada (Statistics Canada, 2015, Table 13). While there has been significant growth in women's participation at the tertiary level of education, challenges remain in STEM related fields with only 21% of women representation in 2016 (Statistics Canada, 2021b).

A gender gap also persists in the rank at the university level, with women holding only 18.8% of full-time faculty positions (Robbins & Simpson, 2009). Additionally, research indicates that "women faculty are not appointed to the rank of full professor at the same rate or speed as men" (Drakich & Stewart 2007, p. 8). A plausible explanation for women's lack of participation at the tertiary level has been that "women have had to function in environments that favor—sometimes deliberately but often inadvertently—the men who have traditionally dominated" in this sphere (Shalala et al. 2006, p. 3). Census data of women aged 35-39 showed that "half of women academics do not have children" (Robbins & Simpson, 2009) and they "tend to put in longer hours, are less likely to marry, and more likely to separate or divorce (Mason & Ekman, 2007, p. 45).

Closing Thoughts

The educational system in Canada intends to provide women with equitable opportunities to access higher education and there has been noticeable expansion in the numbers of enrolment at the post-secondary level. Although women are provided with equal opportunities, there is a noticeable gender gap that widens as women progress along their educational path. Specifically, the representation of women in mathematics fields reflects their lower participation in comparison to the growth experiences in fields such as education. As a starting point, institutions need to be more responsive to the challenges women face beyond the classroom. A common view shared by researchers is that equity-related change comes from academic leadership (Agocs et al., 2004; Robbins & Ollivier, 2007) When educational systems fail to be gender-sensitive and gender-inclusive, it should be taken as a failure of leadership.

Chapter Three

Methodology

"We do not learn from experience … we learn from reflecting on experience"

—John Dewey

Preamble

This chapter outlines the methodological considerations and the decisions that have guided my research, notably, my desire to understand how women align their personal narrative with mathematics education. Narrative inquiry complements this pursuit as it provides a way to study how humans experience the world. It supports my conviction to invite participants into the research process and learn from their lived experiences. Narrative inquiry is situated within a "matrix of qualitative research" because it focuses on the experiences of life. A strength of

qualitative research is that it "creates a more complex picture of what is going on within culture-sharing groups and in participant settings" (Caswell, 2011, p. 23). It is therefore extremely important that I share with you my reflective stance (see following section) so that my position is clear when analysing the lived experiences of women. Narrative allows me to interpret the meanings to which women ascribe their experiences and provides a holistic lens to explore human experiences as phenomena.

This chapter is divided into four sections. I begin with my reflective stance, recounting my personal journey and sharing necessary background information to this inquiry. In the second section, I provide an overview of narrative inquiry, as well as my rationale for selecting a narrative research design. The third section describes my research design, including an introduction of my research participants, my research questions, and methods for data collection, analysis, and representation/re-presentation. The final section addresses some of the ethical implications of engaging in narrative inquiry.

Developing a Reflective Stance Before the Inquiry

My interest in the topic of women in mathematics education is derived from my personal experience of learning mathematics, and the critical moments that have shifted my understanding of what it means to be "good" at mathematics. As I prepared to commence my master's thesis, I wondered, *what do I really want to know? How was I going to contribute new knowledge to the field of mathematics education? Would I be able to capture authentic stories and experiences from educators who may be hesitant to share with a graduate student? What can participants gain from this experience? What research design was best suited for this inquiry?* All these questions invoked immense pressure, doubt, and fear. I felt pressure working with women who were familiar with the literature, and I hoped that my research would contribute something new.

I doubted my own knowledge of research design, revising my plan multiple times before arriving at narrative inquiry, while fearing that my personal experiences would impact the trustworthiness of my inquiry. Harboring these feelings, I immersed myself in literature, looking for ways to design my study so that it was reflective of my participant's journey. Although this inquiry was provoked by my own curiosity, it evolved into a study that valued participants' voices and accepted their personal stories as knowledge. To do this, I had to ask myself, *how do I earn the trust of my participants? How could we move beyond surface-level answers? How could I dig deep and challenge some of their own beliefs?* If I were to do this right, I knew I needed to be transparent and reflective of my own positionality, and how my ideas influence the direction of the inquiry. I began to "lean into my bias" (Driessens, 2018, p. 77) with the understanding that my values and assumptions were unavoidable regardless of whether I wanted them to be (Lather, 1992). With that in mind, I kept a research journal to record my feelings, thoughts, and/or revelations throughout the process.

Throughout the inquiry, I remained highly conscious of how my personal experiences would shape the way I conceptualize ideas about gender, participation, and perceived barriers in mathematics. I anticipated that participants would have experienced barriers along their journey in mathematics education and was likewise aware that they may not have nor considered them as "barriers". I stayed open to learning about each participant's pathway to becoming a mathematics educator and paid close attention to what the data revealed. Upon further scrutiny, I found the data that I originally thought was "irrelevant" had much to share beyond my initial interpretations. I will present this data in Chapter Four and in Chapter Five, I share my interpretations and major themes found across all narratives. Chapter six uncovers a deeper

reflection of my own values, assumptions, and beliefs, and how they were challenged throughout this process as I discuss the research findings and implications for future learning and teaching.

Methodology: Overview of Narrative Inquiry

Narrative can be understood as "a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected" (Czarniawska, 2004, p. 17). Stories are a natural form of discourse in daily interactions, so they serve as an authentic lens to view how individuals understand experiences and construct meaning in their lives. To "accept lived experiences as phenomena" (Connelly & Clandinin, 2006, p. 375), narrative provides an opportunity to discover the social, cultural, and historical context from many different perspectives. Through narrative inquiry, stories are deconstructed to reveal powerful discourses, hierarchies, presuppositions, deliberate omissions, and opposites. Narratives then, are accepted as knowledge, as social reality, and as representative of the richness and messiness of life (Etherington, 2017). A distinct feature of narrative inquiry is the orientation concepts of time and place. Time is an important reference point when locating individuals, events and or ideas (Connelly & Clandinin, 1990). It is the understanding that "every event is an expression of something happening over time: it has a past, present, and implied future" (Schram, 2006, p. 105). Further, that those events can be chronologically ordered to make meaning of an experience. Similarly, place provides the situational knowledge that is required for understanding the social-cultural context of experience (Connelly & Clandinin, 1990). Therefore, narrative researchers understand that our identities are inextricably connected with our experiences in a specific place and how we share stories in relation to the experience within the place.

The orienting concepts influenced my decision to pursue narrative inquiry, as my proposed research questions explore how women come to understand their pathway to participation in mathematics and their identity by locating events and perceptions in time.

Research Design

Participants

My curiosity in the various factors influencing women's participation in mathematics is what led me to focus my inquiry on female educators of mathematics. I sought to understand their journey in mathematics and the critical moments that influenced their participation. In order to recruit participants, two phases of selection occurred (see Table 1).

The first phase consisted of a passive snowball sample where I relied on my pre-existing relationship with five female educators of mathematics to recruit participants to complete a semi-structured questionnaire. In reaching out to their respective professional networks within the Canadian mathematics education community, I received ten responses in total—including the women who initiated the snowball sample. All responses were from women mathematics educators at the post-secondary level. To protect the prospective participants' identities, maintain confidentiality, and encourage voluntary participation, I did not reach out to these individuals (N=10) directly during phase one. I invited individuals who completed the semi-structured questionnaire to provide their contact information at the end if they were interested in participating in the study. The goal of phase one was to assist in generating a larger sample size for participant selection purposes only. Of the ten women who expressed interest in my study by completing the questionnaire and providing their contact details, I selected five participants to participate in my study. I contacted them using the email that they disclosed on the

questionnaire, and I invited them to participate in phase 2 of the inquiry. All five women agreed to participate and became my participants for the remainder of the study.

Table 1

Number of Participants During each Phase of Data Collection

	Phase 1	Phase 2	
Data Collection Methods	Semi-Structured Questionnaire	Semi-Structured Interview	Reflection Activity
Number of Participants	10	5	4

The second phase of this study consisted of a purposive sample of the five participants that I selected from the questionnaire (Appendix A). I recruited Canadian women mathematics educators at the post-secondary level who were selected to participate in a narrative inquiry based on the results obtained from the questionnaire. The women selected to participate were all keen to share their experiences and pathways to becoming a mathematics educator at the post-secondary level. Bernard (2000) argues that purposive, non-random sampling is appropriate for learning about peoples' lived experiences when learning about "their lives" is your research intent (p. 13). In this case, I specifically looked for Canadian women mathematics educators at the post-secondary level who identified as having overcome barriers to succeed in mathematics, given that the objective was to discuss how individuals perceive these barriers and how they have shaped their experiences in mathematics. Therefore, I set out to work closely with individuals who met the following criteria: Participants who (1) identified as a woman; (2) were interested in exploring their own identities and the intersectionality of their position as a mathematics educator at the post-secondary level, and; (3) demonstrated a willingness to share

stories about their lived experiences. If all the above criteria were met, preference was given to individuals who indicated that they had overcome barriers to succeed in mathematics.

Research Questions

As I planned my research and situated myself within the literature, the following questions guided my inquiry:

1. Why do women decide to teach mathematics education at the post-secondary level?
2. What are the experiences of women mathematics educators who had "overcome barriers"? What are the critical moments along their pathway to participation?

In addition, my objectives were:

- To explore the beliefs and perceptions women educators hold about their gender, identity, and mathematics and how they evolve over time.
- To establish collaborative relationships with women in mathematics education by deeply listening to their journey
- To develop narratives that share my participants' truths, and in a way that honours their journey
- To understand what influences women's participation in mathematics education

Data Collection

Data collection consisted of a semi-structured questionnaire, interviews, and visual materials. During the first phase of data collection, I sent a Google forms questionnaire to five women mathematics educators at the post-secondary level. These women indicated that they would be willing to support my research inquiry by forwarding the link to their professional network of Canadian women mathematics educators. The purpose of the questionnaire was to aid in the selection of participants for the narrative inquiry. The questionnaire consisted of seven

agree or disagree statements, in addition to demographic information. All questions include a comment box where participants could further expand upon their initial answers. I intentionally included space for women to share their voice at the beginning of the inquiry in an effort to establish a collaborative relationship. According to Britzman (in press):

> Voice is meaning that resides in the individual and enables that individual to participate in a community … The struggle for voice begins when a person attempts to communicate meaning to someone else. Finding the words, speaking for oneself, and feeling heard by others are all a part of this process … Voice suggests relationships: the individual's relationship to the meaning of her/his experience and hence, to language, and the individual's relationship to the other, since understanding is a social process.

The statements provided within the questionnaire were ambiguous and left room for interpretation. It was important to me that participants were given the opportunity to explain why they felt a certain way towards each statement, and that I played what Elbow (1986) called, the believing game; a process of inserting myself in the participant's story and affirming their thinking or perceiving. Information pertaining to the inquiry was provided at the beginning of the questionnaire and participants were informed that their participation was completely voluntary. There was no way for me as the researcher to know which individuals would choose not to participate in phase one. By completing the questionnaire in full, participants were aware that they were identifying themselves as willing participants of the narrative inquiry. At the end of the questionnaire, participants were asked to disclose their contact information, including their names and emails so that I could follow-up with those selected.

The second phase of data collection took place following a review of the data collected during the first phase. At this point, I asked participants to read a new information letter

(Appendix B) and sign an official letter of consent (Appendix C). The second phase consisted of a semi-structured interview and a reflection activity.

Semi-Structured interview.

In the second phase, I conducted a semi-structured interview with each of the five selected participants using Zoom technology. All interviews were recorded, with permission of each participant, for transcription purposes. The interviews were scheduled at times that were convenient for the participants and lasted 60-90 minutes in length. The purpose of the interview was to understand women's participation and representation in the area of mathematics and how it aligned with their personal narratives. It was important for me to spend time with each woman one-on-one to get a clearer sense of their background and lived experiences from their own perspectives. Following the advice of Flyan (2005) who said that questions should serve as a guide for in-depth exploration, while simultaneously creating space and opportunity for flexibility, I encouraged participants to prioritize what was more meaningful to share in relation to their personal experiences in mathematics. Jacob and Furgerson (2012) suggest the use of six to ten open-ended questions to explore a particular issue and to ensure that the interview is of reasonable length for participants. Ten open-ended questions (see Table 2) were developed as starting points with the understanding that we would circle back to certain topics during the reflection activity. After the interview, participant stories underwent a preliminary data analysis (see Data Analysis). Approximately four weeks later, the individual narratives were sent to participants for review.

Table 2

Guiding Questions for the Semi-Structured Interview

Conversation Starters

- Describe your current role as a mathematics educator. *How long have you worked at the university? Are you full time/part time? How many courses do you teach? What is the best part of your role as a teacher educator of mathematics?*
- Describe your past experience of learning mathematics - from your earliest memory up until today. *How did you feel about the subject in elementary school? What grade did you typically receive? What contributed to your decision to pursue mathematics in higher education?*
- Who influenced your decision to study mathematics beyond elementary school? *How did your mother or father feel about girls in mathematics? Was there a teacher who encouraged you in mathematics?*
- What was the most important reason for choosing a career path in mathematics education? *What were your abilities/interests? Did you have any salary expectations? What was your perception of mathematics education as a career?*
- What does it mean to be competent in mathematics and how do you position yourself? *Do you learn quickly? Is math challenging for you?*
- How do you describe your confidence in mathematics? *How comfortable are you teaching mathematics? What makes you nervous about teaching mathematics? When did you realize your confidence in mathematics?*
- How do you perceive gender equity in mathematics education? *What is your definition of equity?*
- In your opinion, what are the greatest barriers of women's participation in mathematics?
- What is your role in addressing gender equity? *How do you encourage women in mathematics? Does your identity as a woman impact your pedagogy? What challenges do you face as you try to teach more equitably?*
- Tell me about a time when you promoted confidence and willingness to continue mathematical self-development. *What research are you involved in, are there any strategies that you implement as part of your mathematics instruction?*

Member checking was an important part of this inquiry in an attempt to reduce misinterpretation (Thomas, 2017) and to ensure accuracy. I was also sensitive about maintaining privacy, as the community of mathematics educators at the post-secondary level is quite small. Member-checking provided an opportunity to informally reconnect with each participant and elaborate on their stories to add breadth and depth to the inquiry. Initially, my participants began sharing stories of triumph that involved them overcoming obstacles such as teaching themselves mathematics in school or finding strategies to cope. I understood this to mean that my participants were keen for me to develop a narrative of them as resilient women of strength. As I returned to my data and began to view it from a critical feminist lens, I realized that these women

were perhaps unaware of how resilient they were, specifically given their gendered experiences and barriers of societal expectations. Member-checking gave me an opportunity to share my feminist analysis with participants and to discuss some of the more subtle and complex issues that existed within their journey to becoming a mathematics educator.

Reflection.

Reflection is a critical aspect of feminist research and therefore, it was equally important for me to give participants the opportunity to reflect on their experiences independently. After our first interview, I provided participants with instructions for the reflection activity (Appendix D). The instructions asked participants to draw an arrow representing movement of their mathematics journey from their earliest memory up until today, and to plot their most critical moments in mathematics along that timeline. The method of using visual representation for reflection is grounded in theories drawn from feminism and critical pedagogy. This form of visual data collection reinforces a belief that people communicate in different ways and can connect differently with ideas if they are presented in a visual format (Clark et al., 2013). Since the goal of my inquiry was to explore in depth the experiences, perspectives, and voices of women in mathematics education, this approach was an appropriate choice of methodology. The purpose of the visual representation was to invite women to share their experiences in an open and honest way. A reflection activity, lasting one to two hours in length, took place with four out of five participants (Sophie chose not to participate in the reflection activity) over Zoom technology to discuss what was happening in their lives during each moment, what beliefs they held during that time, and to further clarify how the experience limited or contributed to their success in mathematics (Appendix E). In doing so, it was my intention to find patterns and connections across their experiences, without erasing differences and complexity (Creswell,

2007, p. 32). During this activity, I presented follow-up questions to allow room for retelling and reconstructing experience and meaning. I constructed questions based on responses from their interviews and my initial observations which allowed participants the freedom to reconstruct their stories or expand further.

Data Analysis

I began data analysis by listening intently to each interview, noting my personal observations, reactions and wonderings while watching the recording. Items that stood out were flagged for future enquiry. The preview of analysis during this phase allowed me to become familiar with the data while identifying subtle themes as they emerged. In an effort to honour the individual stories of my participants, two levels of data analysis were performed: *within* narrative analysis and *across* narrative analysis.

Within narrative analysis.

This level of analysis involved the re-storying of interview transcripts by organizing them in chronological order and situating experiences in time and place while generating a broad overview of major themes *within* the individual story. The re-presentation is influenced by the Clandinin and Connelly (2000) three-dimensional space approach which in turn draws on John Dewey's criteria of continuity, interaction, and situation of lived experiences (Wang & Geale, 2015). The three aspects of this approach (shown in Table 3 on the following page) suggest that to understand individuals, we must look at their personal experience as well as their interactions with others. In this inquiry, interaction was a critical feature in understanding women's perceptions of mathematics and the factors that influenced their participation. Continuity revealed insights along participants' journeys to becoming a mathematics educator, by analyzing past and present experiences and how they have evolved over time. Generally speaking,

individuals progress through education starting in elementary school, then secondary school, and into possible higher education after which they enter the workplace. Therefore, the education system allowed for comparison between women's experiences during similar stages regardless of the length of their journey. Context was provided by situating lived experiences in a place that provides meaning to the experience. Participant reflections provided an opportunity to discuss emerging themes in greater detail and discover what was happening at specific points in time. This process is based on the notion that our identity is inextricably linked with our experiences in a particular setting and how we share experiences through the stories we tell. Beyond re-presenting women's lived experiences chronologically, I also detailed central themes that arose to provide a more detailed discussion of the meaning behind their stories. I used Atlas.ti software to code data line by line to identify important details and emerging themes. A visual representation of their journey in mathematics is provided where critical moments are situated in time, place and interaction based on Clandinin and Connelly's (2000) three-dimensional space approach. Chapter Four provides a detailed description of each narrative and the central themes emerging from it.

Table 3

Clandinin and Connelly (2000) Three-dimensional Space Approach

Interaction		**Continuity**			**Situation/ Place**
Personal	**Social**	**Past**	**Present**	**Future**	
Look inward to internal conditions, feelings, hopes, aesthetic reactions,	Look outward to existential conditions in the environment with other people and	Look backward to remembered experiences, feelings, and stories from earlier times	Look at current experiences, feelings, and stories relating to	Look forward to implied and possible experiences and plot lines	Look at context, time, and place situated in a physical landscape or setting with

moral dispositions	their intentions, purposes, assumptions, and points of view	actions of an event	topological and spatial boundaries with characters' intentions, purposes, and different points of view

Across narrative analysis.

The second part of the analysis was performed following completion of individual narratives (*within* narrative analysis). The purpose of the analysis at this point was to identify major themes across the women's experiences and their journey towards mathematics education. Overarching themes were generated by reviewing transcripts, re-coding and grouping codes from the data, and comparing and contrasting big ideas across all five stories. The two-level analysis allowed me to participate in re-storying my participants' lived experiences as well as provide me an opportunity to become a story-analyst to discover shared experiences. The following chapter re-tells each woman's journey in becoming a mathematics educator and the major themes found within.

Ethical Considerations

Narrative inquiry requires researchers to engage in the process of reflexivity and challenge their own ways of knowing, doing and thinking as a way of understanding participants' lived experiences from their personal perspective. For me, reflexivity is the process of locating myself within the research and "identifying my standpoint" (Scheffel, 2011, p. 55), including how my personal views towards women and mathematics influence the research process and my interactions with participants. Researchers of narrative inquiry are in a constant state of limbo between their intimate relationship with participants and their role as a

professional in the scholarly community (Clandinin & Connelly, 2006). Smith and Sparkes (2006) emphasize that in storytelling:

> The ethical and heartfelt claim is for a dialogic relationship with a listener (including the researcher), that requires engagement from within, not analysis from outside, the story and narrative identity. Consequently, the goal and responsibility is to evoke and bear witness to a situation the researcher has been in or studied, inviting the reader into a relationship, enticing people to think and feel with the story being told as opposed to thinking about it (p.185).

To reduce the risk of imposing meaning on participants' lived experiences, I regularly reflected and considered my own biases, assumptions, and opinions, and used dual-level analysis.

To my knowledge, there was no physical, financial, legal, or social impact to any of the participants in this research inquiry. I considered the possibility that traumatic subject matter may emerge, resulting in psychological or emotional stress and harm for participants. Specifically, subject matter discussing ongoing histories of sexism and other forms of discrimination could result in psychological injury to the participants. They were informed of the potential risks associated with the study through the consent form made available to them before research commenced. I also provided many recommendations to participants at the onset of this inquiry, in the event that they experienced these reactions during the study.

I recognized that the topics of gender and identity can be sensitive in nature. I accounted for this by ensuring that only the participants described their identity as well as provided ample opportunity for meaningful collaboration throughout the study. Given that these were women educators sharing personal experiences and perspectives, protecting confidentiality was paramount. During my analysis, I was highly sensitive to identifying details and ensured that

participant narratives were written in a way that protected their identity. In addition, pseudonyms were mutually decided upon between the researcher and participants. Member-checking was employed throughout the study so that participants were comfortable with the information that was being disclosed. Prior to collecting any data for the purpose of this inquiry, I obtained approval from the Research Ethics Board and strictly adhered to ethical guidelines throughout.

Limitations

This study intentionally has limited generalizability. I wanted to explore women's experiences and structured the methodology to allow for an in-depth reflection. The perspectives, experiences and narratives in this inquiry are reflective only of a small sample size of five women across Canada and thus do not reflect the diversity of opinions, experiences, and narratives of all women mathematics educators at the post-secondary level. The goal of this study was not to promote generalizability but rather, to *deeply* understand women's participation in mathematics education which could only be done using a smaller sample size. Time was also a limitation in that I only spent two to three hours with my participants. This provided a glimpse into their journey to becoming a mathematics educator but there is still much to discover about their personal identity and how it was constructed from the various lived experiences.

This study is also limited in perspective. Although I selected participants with various backgrounds including two women with tenured positions, one woman without a formal PhD, and two women who are contract employees, I did not interview any male mathematics educators, or members from the pure mathematics community, nor did I interview any pre-service teachers. It might have been useful to examine the ways that men and women are socialized differently and explore the messages they are given about what is expected from them in their families, schools, communities and society. Also, I recognize that gender is further

shaped by race, class, sexuality, culture and geography although my inquiry does not expand to that length. My research therefore does not reflect the various insights that those groups might bring. It is possible that the lack of participation from Sophie in the reflection activity is a limitation of this study. She provided fruitful insights during our initial interview that allowed me to continue with the data analysis without the reflective component. The addition of her reflection may have provided more context to her perspectives that would have supported my analysis.

Further, I specifically looked for Canadian women mathematics educators at the post-secondary level who identified as having overcome barriers to succeed in mathematics. I intentionally selected participants who met following criteria: Participants who (1) identified as a woman; (2) were interested in exploring their own identities and the intersectionality of their position as a mathematics educator at the post-secondary level, and; (3) demonstrated a willingness to share stories about their lived experiences. Undoubtably, this provided a unique perspective from a limited sample group.

Chapter Four:

Results: Sharing Stories of Contemplative Introspection

"We need women's language, a language of experience. And this must necessarily come from our exploration of the personal… [a] women's lived experience"

(Stanley & Wise, 1983, p. 146).

Preamble

What does it mean to establish trusting relationships with participants? How do you go off and analyze personal aspects of their lives? What does it mean to research with your head and your heart? How do you ensure that you share personal stories in a way that honours their experiences? Who am I to share their story? How do I make my research meaningful for my participants? These are the questions I am left with now that the formal data collection has come to an end.

The analysis of this inquiry is presented in two parts: Chapter four and Chapter five. The goal of Chapter four is to present the individual stories of each woman and their journeys to becoming a mathematics educator. My intention is to preserve their stories and share them in a way that honours my participants' lived experiences. In an effort to illustrate the lived experiences of my participants, I have written a poem to introduce the beginning of each narrative to establish connection and to set the scene for my analysis. Participants were invited to share their journey to becoming a mathematics educator during our initial interview and subsequently had an opportunity to reflect on their critical moments that influenced their participation in mathematics. Their reflections provided a deeper understanding of their lived experiences, as they shared stories about their beliefs and perceptions towards their identity and how it has evolved over time. I present my findings in a consistent manner, with a detailed

account of their journey in mathematics and their envisioned future. Following the researcher's re-presentation of each story, the within-narrative analysis highlights emerging themes from *within.* Their responses shed light on the different experiences in schooling that shaped their individual identities, and on the various factors that may have influenced participation in mathematics, leading to their current role as a mathematics educator.

Using only the results of the selected five participants, the preliminary questionnaire provided fundamental insight on their backgrounds and revealed that they varied in academic tenure between having five and twenty-five years of teaching mathematics education at the post-secondary level. Differences were also found in employment status with 40% contract, 20% tenured track and 40% tenured. Among variances were their educational backgrounds with 60% of participants indicating that they had a special emphasis in mathematics—including mathematics-related subjects such as statistics—as part of their undergraduate coursework. All participants have a major in mathematics education at the graduate level. Only 40% indicated that they hold a minor or special emphasis in mathematics as part of their graduate coursework. The majority of the participants (60%) agreed that they were quick learners in mathematics. However, almost all (80%) participants disagreed with the statement "I have always felt confident in mathematics". All participants agreed with the statement "we need more women engaged in mathematics". All women shared that they have thought they were "not a math person" at one point in their life.

As I began the process of analysis, I was overwhelmed by the amount of data that emerged. I had only spent two or three hours with these women and, yet their ability to open up and share their most vulnerable moments, in an honest way, gave me permission to explore their world of knowing. At times, I felt as though I could only capture a snapshot or fragment, and it

was then where I was reminded of my commitment to storytelling—to connect pieces of experience, weaving the narrative together into cohesion (Ellington, 2011). With the data in front of me, I began reading, organizing, coding, and referring to my notes. I remained open and trusted the analysis process, hoping that the data would lead me in the right direction.

Within Narrative Analysis Results

Julia's Story: Illuminating Light in the Shadow of Patriarchy

Do you see me?
You've taught me well and I know what to do.
I hide the pieces of myself that don't fit, so as not to offend you.
Do you see me?
I show up and perform, but is it enough?
When I politely question, it's met with rebuffs.
I'm tired of proving my worth to surpass,
and choosing my words just to make you step back.
Opinions and judgement, none of it true.
It's time for a change, transformation is due.

Past: Early Years of Mathematics Education

Julia's earliest memory of mathematics education involved a strategy to help her solve multiplication problems. Julia struggled to memorize her multiplication tables, so she used her pencil to tap dots on her paper that kept track of repeated addition. She would begin with numbers that she knew the answer to and count up from there using a visual representation of dice. For example, if the question was four multiplied by six, Julia would start by multiplying two and six which gave her the answer, twelve. Then, she would continue counting from twelve, tapping her pencil two times (for each set of six), adding a dot in the order of dice dots until she got the answer of twenty-four. She remembered that her teachers were really frustrated with her method because her papers appeared "dirty". This was a result of erasing her visual representations. Julia had developed a strategy that worked, but it wasn't the one that she was taught, and she often wondered why no one asked why she was doing it that way. Over time,

mathematics became a subject that Julia tolerated, and her aversion grew stronger as she was forced to participate in games that required public demonstration of mastery, and quick recall skills. Although Julia refuted the process of learning mathematics, she recognized the importance of education—whether that was a result of her upbringing or her desire to help others—and she was determined to succeed in school. For Julia, success was defined by a strong commitment to her responsibilities as a student, reaching high levels of academic achievement, and being kind to others—in her mind, being a good human being.

Towards the latter half of her elementary schooling, her family relocated, forcing her to change schools. The transition was difficult, and everything felt foreign. She entered a new school with new teachers, faced with the challenge of forming new friendships and relationships. Julia commented on this experience, saying that "everybody had known each other, since kindergarten… they were tightly mashed in their own little groups, and here I am … an outsider … seen as less than … where I didn't fit in … so [it] was pretty rough".

In secondary school, traditional algorithms and computational processes remained the acceptable form of "doing" mathematics. Julia admitted that she couldn't listen to the class lectures or retain the information in secondary school. In fact, she would often take her math book home, read through it on her own, and teach herself the concepts. She was less interested in knowing how to solve a problem, and more interested in understanding the problem. Julia also noted that her push to understand mathematics created tension within the home, stating:

> My dad used to try and help me with homework that ended catastrophically though, because I wanted to know why I was doing things and he just wanted me to do them, and I don't even know that he actually understands why he did some of those things… he didn't need to know why…once he internalized it, it was fine. Teaching was not his

> strong suit [and] I remember screaming matches at the dining room table that mom used to have to come, so there ended up being a rule in the house, that dad was no longer allowed to help me with math homework… he would just get so angry and my dad's a very calm, peaceful person so the fact that my *whys* pushed him to the point where he was yelling, [that] was enough for my mom to be like, we're going to call a time out on this.

Despite earning exceptionally high grades in mathematics, Julia hated the mechanical aspect, so when she was able to stop taking math courses, she did. A deeper discussion on her academic achievement and school interactions revealed the tension between her reputation as a good student and her desire to be "unseen". As Julia opened up about her personal life, she confessed:

> The only thing I had was my grades, and everybody knew who I was because I used to blow the curves in most of their classes—but…so, there was the fear of you know, still doing that because it made people notice me, and wanting to not be noticed and disappear—I didn't want to lose that, which is what made me work so hard on trying to learn the math and I just gave up on needing to know why or needing to know any of this stuff…I just needed to get the good grades.

When Julia entered the workforce as a teacher, she mentioned that she was drawn to language arts and remained disconnected from math. She claimed that her students felt it too, but she had no idea how to fix it because she was implementing the strategies that she had been taught. She recalled learning how to show students how to use manipulatives in her professional education program, something she later realized was problematic, noting that the students should be showing the teacher how *they* use the manipulatives. The lack of freedom that she felt in mathematics ultimately resulted in her decision to prioritize language arts as the area of study in

her Master of Education. She confessed that she knew language would be easy and at that time in her life, she needed something to build up her self-esteem. Julia rationalized her decision to participate in language arts over mathematics in the following excerpt:

> I could memorize the formulas, I could spit out answers, but to me that was boring, whereas writing, there were so many different ways, you could take it. There was so much creativity, there was so much beauty in it, and that was kind of what I was drawn to.

Julia worked as an elementary teacher while attending school for her Master of Education. She enrolled in an elective mathematics course as "a strong student" and viewed it as an opportunity for professional development. In describing how this came to be a critical moment along her pathway, she said:

> We didn't have a lot of choices and it was the only one that made me think yeah, I guess, I could do this, maybe I'll learn a thing or two. And that first course changed my entire life … that first day we did something with patterning and for the first time in my life algebra made sense. And when that click happens, I just wanted to know more, and that's when I dropped my supervisor … and I completely switched to doing mathematics.

Her experience in higher education was a period of transformation. Eager to engage with the community, Julia attended both mathematics and mathematics education conferences to showcase her work. The more that Julia participated, the more self-aware she became as a woman in the field of *mathematics* education. As she reflected on her first experience attending a conference as a professional, she shared that an older gentleman approached her and asked if he could help her find her boyfriend. She recalled: "In the moment I was like well, he was caring, but later, as I look back, I'm like, why did you assume I wasn't the academic? Why did you think

my boyfriend was in the room?" As a professor, she noted that male students would often comment on her appearance, stating: "they have boiled down what the best thing about this course to the teacher is hot. I had something to look at. That's what you took from my course? That's what you saw? Or I liked her shoes". She further explained:

> My heels make me feel *powerful* and *confident* and I wear them for me. I don't wear them so somebody else can comment on how great it makes my butt look in my course evaluations … it was really jarring that, that was what they saw me as.

During our conversation, Julia shared feelings towards multiple encounters of gender bias and the effort that has been required to be taken seriously in the field of mathematics education. A defining moment was during her PhD when her voice was silenced by a male professor. Fearful that she may not pass the course if she spoke out, she recounted:

> I was sharing a story and he said that unless I developed a thicker skin and all of *you* people, meaning women because we were all women in the course, will never make it [in academia]. Nobody responded to his comment, nobody touched it … But I actually felt like I needed to say something. I just didn't feel safe to be able to say it, and it's interesting because the people in my class have brought it up at different moments when we've had interactions later. That was a defining moment for them as well.

Further tensions between her personal and professional identities surfaced as she remembered her decision to continue in the PhD program while a significant family member fell ill. She persisted with her PhD knowing that it would make her family proud, but she recalled that it was an internal struggle for her.

Present: Being a Mathematics Educator

Julia maintains separation between her personal life and professional life as she continues to construct her identity in the world of academia, conscious of how her decisions impact future career opportunities. In describing *who* she is, Julia identifies as being a teacher. Every decision she has made along her journey has been with the intention of becoming a teacher and she does not separate what she does from who she is. For Julia, a teacher "encompasses confessing the idea of being the parent; being the caregiver." She expanded on this thought, sharing her desire to become a mother. On a very personal level, teaching allowed her to fill a part of herself that was missing. She admitted that this is one of the reasons that she struggled with making the switch from teaching elementary to teaching in academia. She was afraid that she would lose an important piece of herself in an effort to maintain her status in academia.

Future: Envisioning Change

A fundamental belief held by Julia is that every student can be successful in mathematics when provided with opportunities to explore how they learn best. Her definition of success has evolved to ensure that academic achievement is connected to a deeper understanding of what mathematics is, and who can do mathematics. In a discussion about what needs to change in mathematics, she asserted, "we need to shift the hierarchy and once we break that down, and the elitism around mathematics, I think that's going to make a big difference". She suggests that society needs a broader definition of what is valued in mathematics, so that calculus is no longer considered the leader and ultimate definition of success. She reasoned that:

> Unlike most other subjects, parents have a lot to say about what should be happening in mathematics. I think there needs to be a more unified message about why this [alternative

> method] is good for their child. Yeah, you may not see them writing out long division, but it doesn't mean they're not dividing.

Central Themes in Julia's Story

During Julia's first interview, I had a hard time reading her. I observed as she politely smiled and answered my questions, trying to discern what she was thinking. She came across as warm, kind, unsure, thoughtful and it was apparent that she was someone who wanted to put her best foot forward. I sensed her initial reservation at the time, and I wondered if I had done something wrong. I couldn't decipher: *Was she judging my study? Was she interested in my topic? Were my questions too personal? What was she holding back? Was she comfortable to share the personal details of her life? How would I establish trust?* Towards the end of our first meeting, she allowed herself to be vulnerable and revealed some of her fears of participating in the study, one of them being perceived as a "whiny, emotional female". By acknowledging the fear and accepting the discomfort of being vulnerable, an honest dialogue began to take form. Her disclosure of some very personal information was a reflection of profound resilience in her journey to becoming a mathematics educator. As she reflected on the critical moments along her pathway to becoming a math educator, the conversation cracked open and I began to deeply understand the intimate aspects of her journey.

Her story represents two major recurring themes as important foci for analysis: (1) *Gender, awareness, and belonging* (2) *Coping and working through* with *fear* as a pertinent subtheme.

Gender, Awareness, and Belonging

From a very young age, Julia understood that those around her held certain expectations of her. She was distinctly aware that her actions impacted the opinions of others, as seen in the

example of her multiplication strategy that caused her teachers to become upset with her. While teaching elementary math, she was conscious of how her teaching methods influenced her students and that they were not effective. In higher education, she became acutely mindful of gender bias, and how it impacts the way that others view her, and the way she views herself. In discussing how gender relates to her current position, she said:

> I don't always feel safe to be who I actually am. I feel like it's gotten to the point where I've tried to dial back the female, like I don't always wear jewelry or I don't always wear makeup or I don't always wear heels, and like I've made these shifts. I don't feel good about the fact that I'm making them, but I don't know how else to exist in this world and feel comfortable when there are people who see those things [as negative].

This excerpt illustrates the internal tensions that exist for Julia as a woman working in academia who is required to omit pieces of her identity to fit societal expectations. Her reputation was built upon the expectations of others and a desire to belong. This theme influences her decisions and projects an outward appearance that is disconnected from who she really is. She indicated that awareness and the preconceived notions that she doesn't belong, forces her to speak in a way that "physically makes people take a step back, where they go from oh, to whoa."

She admits that the world of academia is one where individuals "compete against each other for everything" and acknowledges that it is problematic. In a sense, she is required to minimize aspects of herself and highlight others to make herself more marketable in the field of mathematics education. Internalizing her identity has become a form of survival.

Coping and Working Through

Coping has been a prominent theme throughout her story. In the early years of learning, Julia knew that she needed to be successful in all subjects, so she began developing strategies to

help her cope in mathematics. Although many strategies supported her understanding of mathematical concepts, there were times when coping led to decisions that challenged her own integrity. The decision to cheat on a test, copying answers off the little boy who sat in front of her, is a memory that depicts her desire to succeed in school. Relocating was a significant part of her journey that led to deep despair. Her desire to be seen as the girl with the grades accounted for the lack of fit that she felt internally. Working through her emotions silently, during the formative years of her life, demonstrated her strength and stability to work through issues. Her decision to pursue higher education, and the grit that it took to overcome the barriers that were laid in front of her, further illuminates her resilience.

Fear. Not only is the process of working through fear essential to her story, but also identified fear as a prominent theme from the beginning. From the moment we met, Julia had reservations towards sharing the details of her life in fear that it would tarnish her reputation. Fear is woven so deeply throughout her journey that it seems to inspire her growth. She noted that the decision to pursue mathematics as an area of interest in her master's program was terrifying because it meant being pushed out of her comfort zone. Similarly, she shared how difficult it was to leave the comfort of elementary teaching to pursue her career in academia, in fear that she would lose a piece of herself that was truly cherished. It became apparent that many critical moments along her pathway to becoming an educator have involved her ability to push through fear. When discussing her participation in this study, she explained that "we're so terrified to talk about these stories and it leaves us feeling like we're alone…I think as academics, we're still very afraid to admit weakness, or vulnerability, or that were different." Looking towards the future, fear is the one thing that holds her back from speaking out against issues that she firmly believes in.

Sophie's Story: Re-imagining Mathematics

I knew I would go somewhere
I would land right on my feet
Even when I was unsure at times
Where this deeper place would lead
I knew I would go somewhere
I'm still learning as I go
But in this place, there's meaning
I am free to take things slow
I knew I would go somewhere
But I did not go alone
Through the beauty of becoming
I have entered the unknown
I knew I would go somewhere
I got the academic degree
this work, it truly matters…
Math is now a part of me

Past: Early Years of Mathematics Education

Sophie was a keen student who enjoyed school. She described herself as an "artsy little kid" who spent a lot of time drawing and painting—full of energy and creativity. Sophie recalled her educational experience of learning mathematics as "boring", consisting of worksheets and rote practice. She openly expressed her dislike towards the subject and recounted a conversation that she had with her grade five teacher in the following excerpt: "she said, 'well, why aren't you getting on with your work?' and I said, 'because it's so monotonous', and she said, 'yeah, you're not using that word correctly, that means it's the same on every page' and I said, 'exactly … *monotonous*'". She recalled that her mother was highly aware of her frustration in mathematics and would often say, "it's so sad because you are smart but it's not creative enough for you". She mentioned her father was "one of the youngest chartered accountants ever certified in the province" and was very mathematical. Her mother also worked, which was rather unusual for the time period. Though her family placed education as a top priority there was never a push towards mathematics specifically, and Sophie noted that the expectation was that "you do something".

She stated that her parents were supportive of whatever path she pursued, but she never considered that she would not attend university after high school.

In secondary school, Sophie remembered mathematics becoming more “abstract” which presented a greater challenge to her because she had to go home and teach herself all the concepts. She recalled some really good teachers who were more creative in the way they presented the material (e.g. games and puzzles) and that she enjoyed mathematics in those classes. She described herself as a visual learner who spent her time “drawing and creating models” as a way of making sense of what was happening in the equations. During this period, Sophie began to wonder whether her teachers deeply understood the math they were teaching and noted that whenever she questioned or challenged anything in mathematics, the response was dissatisfying, “that’s just how we do it”. Sophie suggested this as one of the reasons she was discouraged from participating in mathematics and was instead more interested in language arts, anthropology and psychology, which she later pursued as a degree in university.

After university, Sophie travelled extensively around Europe and Africa, working for a consulting firm where she applied more “contextual mathematics”. The birth of her son was a pivotal moment in her life from a career perspective, as she realized that flying around the world was not conducive to raising a young child. This ultimately led to her decision to move back to Canada to consider her future career opportunities. She mentioned that she previously worked with children in summer camp and while trying to determine her next step, her father suggested that she become a teacher. At the time, Sophie mentioned that she had no interest in becoming a teacher but when her son was old enough to attend school, she began volunteering at his school. She quickly realized that she enjoyed working with children, so she returned to school to obtain her teaching degree. After graduation, Sophie began working in a self-contained classroom

composed of students who had various learning exceptionalities in addition to other co-morbidities. In describing her experience, Sophie said:

> We spent a lot of time trying to figure out how to access these kids' brains, so that they could start to understand concepts, and it was fascinating trying to think about different approaches to take … it pushed me because I really had to think beyond what I had just been taught in teachers' college … like how I reach these kids, and what can we possibly do.

As she tried different things and noticed that they were working, Sophie realized that she didn't understand *why* they were working. With a desire to do better for her students, she decided to pursue a Master of Education which would enable her to map out the trajectories of learning for all sorts of students. She explained:

> Math was so cool to pinpoint in terms of how people were, and were not, understanding it…at the heart of it, there was like a concrete thing happening in people's brains, and then that all gets extracted out … [then] I became very fascinated with how children understand patterns … [I began to] think abstractly and algebraically about functions and relations with [students] … how very [young] children have the propensity to think about patterns in a very complex way that we didn't seem to be tapping into.

Although her research focused on mathematics, it was shaped more by her background in psychology and her curiosity for the various ways that individuals come to understand mathematics. Building on the foundation of her master's work, she rolled her research into a doctoral thesis and subsequently a book. In reflecting on her experience, Sophie considered how her journey had been influenced by her son. She said:

> I guess the really interesting thing that you're making me think about, is the fact that I [entered teaching] because of my love for the students … and I don't know if that's a maternal thing because I also was a mom of a pretty young kid at the same time, so I was wanting to take care of everybody, and do the best I could for them … that certainly was my drive for wanting to pursue higher education, [I wanted] to do what was best for the kids I was working with.

While completing her doctoral degree, Sophie began working as a mathematics educator. Shortly after, she received a tenure position which involved "publishing like crazy" and "spending the entire summer photocopying and putting together binders for the tenure committee". Reflecting on her accomplishments, she affirmed:

> It was lovely to have people questioning me about [my dissertation] that had taken four years of my life to create and they had read it as deeply as I had…and so, to have a lovely conversation with these really high-powered math-y people was really great…and getting tenure that conversation was really nice, and when my book came out and I was doing keynotes internationally, it was lovely because I had spent so long on this study and then to finally be able to put it together in the form that other people could use [as a practitioners book] … that was definitely a time when I felt confident.

Sophie chuckled as she shared that "everybody was kind of a little bit shocked" with her decision to pursue mathematics education as a career. Given her earlier experience, a career in a mathematics related discipline did not appear to be a natural path for Sophie, but she said, "[now] it made sense because I could bring it all together".

Present: Being a Mathematics Educator

Sophie continues to search for ways to teach mathematics in ways that people can understand. She does this to make it more accessible rather than making it feel as if it's something that only smart people can do. Her work focuses on mathematics through the perspective of psychology and education, but she admits: "I also have to find the mathematics that is grounded in the stuff that I'm exploring as well". Currently, she is exploring ways to decolonize mathematics, focused on cultural ways of knowing and thinking about mathematics with First Nations people. She describes the ways that she makes mathematical connections in the following excerpt:

> Connections between that math and people who are making snowshoes and stuff like that … or setting traps … or doing beadwork … and the designs of the beadwork that are phenomenally mathematical…birch bark basket making and looking at the optimum size of the height of the basket for the volume, because that gets into derivatives and calculus as well … I had to go back and remind myself how to do that [and make those connections] … but [it's] really cool seeing these grade six [students] kind of play around with [a mathematical] idea that they won't formally meet until Grade 12 or university.

Sophie strongly believes that "everybody thinks mathematically" and that is "a foundational part of being human". She has dedicated a significant amount of time learning how to present math in a way where it provides opportunities for people to recognize that they are mathematical and "they don't have to be scared of it". Sophie mentioned that she reflects a lot on the fact that more than half of pre-service teachers enter her classroom terrified of mathematics and she stated: "[the education system] is doing such a disservice to so many people if that's the case".

In addressing the perceptions that people have of mathematics, Sophie responded in the following way:

> I think most people are acculturated to have math anxiety, but I think it's based on their experiences, and I think that if you change the experiences, you can definitely shift people's math anxiety … it's so prevalent in our society … even the messaging that we hear all the time, like you know people saying 'I'm not good at math' … even now like, if I tell people what I do, I can see them cringe, but I think it's because of the terrible way that we teach it, and assess it, and everything else.

Sophie has worked incredibly hard over the years to counter negative perceptions in mathematics and advocates strongly: "please don't give your students worksheets. It's the meanest thing you can do to a child who is full of energy and curiosity and creativity".

When it comes to gender and mathematics, Sophie acknowledged that there are noticeable differences between the sexes when it comes to societal expectations. She referred to a study where girls rated themselves less competent than males regardless of their ability and said: "I would love to know why that happens, and I think a lot of it is just our society like if you're a girl, you're supposed to be arty or whatever and you're not supposed to be smart". She described the societal perception as: "it's really, really weird" and considered how it relates to her role in academia. She reflected:

> You are making me think of something really interesting though, I think the only time I've ever gotten like subtly challenged, or you know, has been from some of my male students when they initially meet me and they kind of like to test me. And not disrespectfully or anything but I know that they're testing me, because they come up with some random question. And it's like they're judging me in terms of how well, I can

> answer it right, and so, then, if I answer it well, and then they seem to be fine with me, but that that's happened a few times over the years, yeah which is really interesting I don't get that from anyone else, like, I never get that from colleagues or anything and only just some of those, yeah a couple of male students who have had reservations, shall we say.

Sophie indicated that gender equity is changing as the scientific and mathematics community gain more representation of women. Sophie appeared to view gender inequality/sexism as a thing of the past stating that it is "certainly lovely compared to what it used to be". Sophie suggested that "unlink cultural trends (ie. media) where the boy/girl dichotomy remains present, the messaging has changed within the education system" to be more inclusive of both genders in mathematics.

Future: Envisioning Change

For Sophie, moving the subject of mathematics forward requires new ways of teaching and understanding mathematics so that everyone has the opportunity to view themselves as competent in mathematics. Sophie believes that teachers play a crucial role in students' participation in mathematics. She noted that a large part of her research and her role as an academic involves going into classrooms to try out different ways of teaching mathematics. She describes this experience along with the inconsistency of mathematics education in the following excerpt:

> All my research has been classroom-based stuff, so we go in and try stuff out, and the kids are doing really complex math, like they're doing really robust math. But they make a distinction between the stuff that we do and school math … They always say, 'oh I love the stuff we do', and 'you come in and we're doing all this cool stuff' and they're doing

> brilliant math, but then they don't see it as school math … unless they've got a brilliant teacher, in which case it's just part of what they're used to.

Sophie uses the term "brilliant teacher" to describe an educator in mathematics who is engaging students through problem-based learning where there are multiple entry points for students to demonstrate their understanding in mathematics. She said, "in so many classrooms that I've worked in, [when] the teacher really knows what they're doing, the kids love it and they don't have math anxiety, and it's all because of the approach that the teacher takes with it". She suggests that "a lot of teachers just assume that they can't do math and so they don't even try to teach in a way that might make sense to them" whereas, the teachers who *are* comfortable with mathematics, often encourage students to participate further in mathematics.

Central Themes in Sophie's Story

Sophie was one of two women in this study who are tenured faculty. Sophie was courteous throughout the interview, refraining from making interpretations of my study even though it is highly plausible, as an academic, that she would carry assumptions about what I was aiming to achieve. Generally speaking, Sophie was assertive in her responses to the interview questions. She challenged the purpose of the first interview question, which was perhaps a reflection of her confidence and curiosity when it comes to understanding the deeper meanings behind everything in life. It was very clear during our time together that she has tremendous passion for helping others understand mathematics and has spent a great deal of time learning ways to spark curiosity and promote confidence in mathematics. Thus, *critical curiosity and confidence* becomes a central focus in her narrative. The second theme, *dedication, and recognition,* constitute an additional perspective to reading her story as a whole.

Critical Curiosity and Confidence

Curiosity was a character trait that Sophie exhibited very early on and continued to be weaved throughout her story. Her desire to understand the deeper meaning behind what she was doing in mathematics was evident in her experience of learning mathematics in elementary school. It had significant implications on her interest in mathematics as she was forced to complete worksheets that closed off her curiosity and consequently her interest in the subject. She further indicated that people were surprised to hear that she entered a career in mathematics, because she was always open about the fact that she did not enjoy it. As she developed creative ways to teach herself mathematical concepts in secondary school, she began to wonder if her teachers truly understood the mathematics that they were teaching. The critical component of her curiosity was evident from the beginning of her narrative, as she describes telling her teacher that the mathematics was "monotonous". Her ability to think critically about her learning experience and voice her opinions to a person in a position of authority, reflects her confidence as a student and dedication to improving her personal education. Her willingness to challenge the way that mathematics is taught in school defines her approach as an academic, in mathematics education today.

In contrast, Sophie does not appear to critically consider why the tension exists between women and mathematics. She appears to be aware of societal perceptions, calling them "really weird" and boldly states that "women are not expected to do well in mathematics but rather, they are expected to be arty". Critical feminists would likely interrogate Sophie's statement by arguing that "power relations render inequalities invisible" (Lane, 2019, p. 19) and the subtle discourses such as hers work against women in maintaining and normalizing these power relations.

Considering ways to reach multiple students with exceptionalities and comorbidities is no small feat. Sophie has spent over a decade understanding the ways in which individuals learn and how they come to understand concepts in mathematics. It is her thoughtful input and curiosity of new ways to make meaning of mathematics that continues to spark dialogue within the mathematics community. Thinking critically about de-colonizing mathematics may provide entry for students who have perhaps been neglected, and further disinterested, in mathematics for many years.

Dedication and Recognition

The themes of dedication and recognition lend themselves as additional perspectives to examine Sophie's narrative as a whole. Their pertinence appeared when Sophie expressed her dedication towards higher education as a result of her family values. The dedication to her research and subsequently her work as a mathematics educator becomes a central focus as her story unfolds. What began as initial curiosity has grown into a lifelong mission to advance the field of mathematics education through her research and teaching practices.

Her dedication to family is also evident in her decision to leave her career as a consultant, acknowledging that it wasn't conducive to having a young child. Her decision to enter teaching as a career was a result of volunteering in her son's school. It appeared that she is dedicated to her family values, while also pursuing her personal ambitions. One might relate this to her own upbringing, seeing her father's achievements as the youngest accountant in the province, and her mother's commitment to step back from the labor force until the children were of age, when she then resumed her career. Although Sophie did not explicitly discuss how her upbringing impacted her career decisions, she suggested that dedication to family while maintaining personal interests was important.

High expectations from Sophie's parents perhaps served as a subconscious incentive to achieve her personal goals. Several points of recognition during the course of her journey became important aspects of inquiry. Strong grades served as confirmation for the work she was doing in elementary school. Sophie shared that she was actively engaged in the community in secondary school, noting that she was involved in the newspaper and yearbook committee which also led to her receiving a prize for contribution in the school through art. In discussing when Sophie feels most confident, she responded: "when I defended my dissertation and then getting tenure". She also acknowledged her book as a critical moment because she had spent so long on the study and was confident in her ability to present at keynotes internationally. In her current role in academia, she continues to achieve awards and recognition in the areas of research and innovation. Despite the fact that her work is worthy of praise and recognition, it seems to keep her grounded. She maintains a humble disposition in sharing her accomplishments, and it appears that the recognition only affirms that her work is meaningful and impactful when it comes to progressing the field of mathematics education forward.

Hypatia's Story: Greatest Act of Service

When I was young and starting out
You led me down this path
As I got older, I showed others
I helped them with their math
We'll take care of one another
I helped them, like you helped me;
I knew deep down I had a gift
and I shared it…unconditionally.
We'll take care of one another
I came back to set you free
And now I go at this alone
And inspire those to see…

We'll take care of one another
this much I know is true
through all the pain and suffering

I'll be right there with you
We'll take care of one another
I'll be right by your side
Relationships, they matter
And surely, you'll survive.
We'll take care of one another
Even when we do not know
we'll work together, heal the trauma…
I'll stand back and smile as you grow.

Past: Early Years of Mathematics Education

Hypatia was captivated by mathematics as a young child, even before she entered elementary school. She remembered her father, an accountant, bringing home punch cards from computers for her to play with. She suggested that her father played a critical role of engaging her in mathematics before she even knew what it really was, and by the time she entered the formal school system, she was eager to learn more about it. Recalling a memory from when she was in grade one, Hypatia stated:

> This is the thing I remember the most…waiting for the bus and my best friend's [older] sister was doing her math homework, she was in like grade six or something and I remember looking at her book and thinking 'oh, I cannot wait to do that math like let me at it', I just loved it.

Hypatia recalled being discouraged between Grade three and Grade five, stating, "[mathematics] was seen as kind of 'manly' or 'not sexy', like I distinctly got the idea that this was not going to be something that would help you get a boyfriend, that was very clear". Her encounters with gender bias and stereotypes were mitigated by her family bonds, and the sense of accomplishment that she felt with being a strong student in mathematics. Having an aptitude for mathematics was highly valued in her household and Hypatia stated that being good at math was something she took pride in.

Hypatia recalled wanting to be a teacher from a very early age and spent most of her time teaching dance classes after school. She mentioned that she came very close to becoming a professional dancer, but her mother resented the idea. Hypatia's mother held high expectations about her future career choices and really pushed her to go into a career that would allow for financial freedom. When Hypatia told her mother that she was going to become a teacher, her mother cried in response because she desperately feared for her daughter's financial stability. This fear appeared to be from her own experiences growing up and Hypatia shared the following excerpt about her mother's childhood:

> She was very poor when she was little, and she also felt like she didn't have choices as a woman when she was my age … she couldn't be a doctor, or a lawyer, and she couldn't understand why I didn't want to be … because I [had the opportunity to] be whatever I wanted.

In reflecting on her personal upbringing, Hypatia described her parents as "very involved". She noted that her father would use math problems as a way of "settling the kids down" before dinner. She described her father as a "natural teacher", stating:

> He always helped me understand the math … [in mathematics education] we talk about breaking things down into parts and chunking and alternative algorithms … he did that stuff for me…it's just how he thought … he was always interested in breaking things apart and putting them back together.

Hypatia appeared to be very self-sufficient when it came to learning mathematics. In describing her elementary school learning, she admitted:

> My teacher just gave me the book and said just go do it, and I just worked on it by myself, like I wasn't even in class. Because I really liked it, and I was good at it, and I

> could teach it to myself faster, so [my teacher] understood that… I really appreciated that because I didn't have to stay at the same pace as the class and be bored a lot of the time.

In secondary school, Hypatia remembered being one of the only girls in her math class and believes that she "stuck it out" because she associated math with her father and the close relationship that they had. She noted that at the time she was very aware that there were people in the world who believed that she didn't belong in mathematics because of her gender. Although she enjoyed mathematics, she noticed that she became more disengaged in secondary school. This was in part due to her shifting priority from education to her social life. Her disengagement consequently affected her academic performance and subsequently, her pathway to future career opportunities. She recalled sitting in the guidance counsellor's office, having a tough conversation about her desire to pursue science in university and realizing that she needed to improve her grades in order to do that. In her final year of secondary school, her mathematics teacher believed in her ability and made sure she knew that. Hypatia remembered her teacher often grading her assignments before the end of class so that she knew what her mark was before leaving, noting that "he didn't have to do that, but he did… and I think that really helped me".

Following her parents' wishes and her own desire to pursue science as a career, Hypatia entered university and was one of three girls in her Physics of Genetics class. She remembered that her professor would turn to the class and say, "okay *girls*, you can get out your knitting, the rest of us are going to do math now" prior to starting a math lesson on the board. Reflecting on her learning experience, Hypatia affirmed that the school system didn't really work for her in a lot of ways. This is why she now focuses her teaching on how to make the school system work for every kid as much as possible. She mentioned that the school system still doesn't really know

what to do with students when they excel and suggested that it remains a big problem in education today.

Hypatia has held various positions in education ranging from elementary, secondary school, college and university, and alternative education. She always knew that she would return to school and complete her Master of Education because she knew it would help her be a better teacher. In sharing her goals for education, she said:

> My goal has been to do professional development, with teachers. I thought eventually, when I'm ready to not teach so much I'd like to do professional development, and I was really interested in this whole project-based math, math connected to real life … my kids have gone to an experiential outdoor education-based school, and I did a lot of work connecting the math to everything that we did there … and I felt like it was something that was missing in the school system, that kids were unengaged, and teachers didn't know how to make it more engaging.

Searching for ways to relate her interest in professional development with mathematics education, she got in touch with an Associate Professor who was exploring ways of connecting Indigenous culture to mathematics education. Hypatia expected to continue her master's, while working with this Professor as her graduate student, until her path took a turn when her father became ill. Hypatia described this critical transition in the following excerpt:

> I had packed up all my stuff, I was moving to go live on campus and finish my master's degree and when my dad got sick I kind of shifted gears and we moved out here…I'm a single parent, so it was not a, I mean it was a big commitment for us, but it was doable".
>
> Adjusting to life in a new province, Hypatia recalled somehow hearing about a professor who studied Indigenous based mathematics, and who later became her graduate supervisor.

She exclaimed:

> I was so lucky … [they] were one of five people in Canada who did Indigenous based mathematics and [they] happened to be living [in the same small city] … I went and talked to [them] … and [they] snapped me up so quick.

Hypatia was provided an opportunity to cover a sabbatical leave and was highly encouraged by her supervisor to participate in mathematics education. Prior to their interaction, it never occurred to Hypatia that she could teach at a university level, but everything came together that year and it turned out to be the best job she has ever had.

Present: Being a Mathematics Educator

Hypatia firmly believes that anyone can do mathematics but the anxiety around it prevents them from even trying. Hypatia stated that her ability to do mathematics gives her confidence in the world, indicating that she is "not afraid of a huge part of the world" that involves mathematics. She identified the best part of her job as helping students work through the fear of mathematics and realizing that they can do it. In discussing mathematics anxiety, she eloquently stated:

> People can heal from trauma and that's what we do in this program, we actually heal people from trauma because if someone walks into the class and they start crying because they have to write a math test what else would you call that? Like students will email me and say, 'I just wanted to thank you because I taught math in my placement and I had fun and I didn't think that could ever happen to me' and it makes me cry. These are people who have been terrified of math their whole lives and they aren't afraid anymore, just because we teach them properly.

As a mother, Hypatia has witnessed her own children's anxiety towards mathematics and confessed:

> With both of my children I had to go into the school and say we're not doing the homework and the teachers would fight me [on it] … my son had an [independent education plan (IEP)] that said he had a processing issue, and it took him twice as long to do anything compared to everybody else, and I went in to talk to the math teacher and she refused to reduce his homework load. I said, 'he cries at the kitchen table every day' and she said, 'sorry he's got to do it'. So, I had to go talk to the principal and her at the same time, and say 'he's not doing it'… Like they put me in a position where I had to defy them and say, 'sorry I'm a math teacher and I'm going to tell him he has to do these five [questions] and that's it, that's all he's doing … and the kicker is, he'd get [80–90 percent] and they still wouldn't let him not do the homework.

In an effort to make mathematics more appealing and engaging for students, Hypatia places greater emphasis on building relationships—both relational and contextual—during class time. She recognizes that "students' don't do the readings" so in her opinion, "using class time to do as much math as possible, gives students the best chance of becoming a good math teacher".

Hypatia cherishes the relationships she has developed with women colleagues in the mathematics education department. She indicated that they were a close group who work together to share teaching strategies and collaborate on planning the course structure. When Hypatia was asked about her position at the university, she admitted that there is a difference between what is valued in academia stating that the academic side is really pushed. The greatest challenge for Hypatia is described in the following excerpt:

> Our program is really demanding, so I feel like I need to not expect too much, because I feel like our students only have so much time and energy, I wish I had more time…and our class size has gone up quite a bit since I started … it's not the same [with almost double the number of students] … I can't give the same kind of feedback [or] the same kind of one-to-one attention, and I think in math that's really important.

Hypatia acknowledges that her identity is somewhat "restricted" without a PhD stating that there are differences "between what you expect, and what the world expects of you" but she truly feels she is in an ideal position because it allows her to focus on the things that really matter to her which is teaching mathematics and building relationships. Hypatia acknowledged that school is a social situation and suggested that when it comes to achievement, girls tend to care a lot more. She strongly advocates for girls in mathematics based on her personal experience, stating that:

> There's an unconscious thing that we do, that science and math are for boys and kids pick it up so young … boys tend to be more confident in general whereas, girls are more critical because the world is a little more critical of us … I think that girls are maybe embarrassed more socially, whereas boys don't seem as upset about it, or maybe they don't show their feelings as much.

She shared that every year, she has a few male students—never female—who challenge alternative ways of doing mathematics, suggesting that when they have their own classroom as a teacher, they will continue to teach traditional algorithms. Hypatia argued that "those individuals are forgetting the education part of mathematics education and are just doing mathematics … that's not teaching … they're different things". For this reason, Hypatia spends a lot of time

discussing the concept of "doing mathematics" and explaining that it is not the same as understanding mathematics.

Future: Envisioning Change

Looking towards the future, Hypatia mentioned that she enjoyed being involved in research during her undergrad and presenting at conferences with her supervisor. The opportunity to work with educators, completing her interest in professional development, would bring things full circle. She mentioned that she enjoys working with educators and discovering new ways to teach mathematics and would love to make a positive impact in the community of mathematics education.

Central Themes in Hypatia's Story

Hypatia's experience sets her apart from the other interviewees based on the teaching positions she's held prior to becoming a mathematics educator, and how they impact her pedagogy within her current role. Given her unique life circumstances, a series of questions came to mind. *What is her story? Was her decision to not pursue a PhD a result of family commitments? How do her family commitments impact her decisions in general?*

The interview was completed over a cup of tea, while Hypatia prepared food on the stove. Her caring and approachable demeanor allowed our conversation to flow freely, without fear of judgement or uncertainty about what I was trying to accomplish. It was evident that Hypatia was comfortable in her home and open to sharing her story with complete transparency and honesty, which was particularly evident when she started sharing about her purpose for moving out of province. Her narrative strongly foregrounds relationships, constantly referring to key people in her life, such as her father, her children, students, colleagues and mentors; perhaps this is a reflection of her family-oriented upbringing. Throughout her story, two themes emerge

as important foci: (1) *Commitment, sacrifice, and perseverance* with *Family* as a pertinent subtheme; and (2) *Relationships,* which will be discussed in the following sections.

Commitment, Sacrifice, and Perseverance

Under the first theme—commitment and sacrifice—Hypatia discussed the personal commitment to completing her Master of Education and the sacrifice that it took to achieve her goal. She acknowledged that it took her nearly four years to complete her degree and it became apparent that she had many commitments beyond advancing her education. She revealed:

> I was working and doing my master's and had two kids at home and my ex lives in [a different province], so I was a 100% full time parent … no one was allowed to do a lot of extracurriculars unless they could get there themselves … so they there were sacrifices on their part, financial sacrifices too, but I kept saying to myself 'they're going to see that learning is important and you can do it anytime and you can go to school whenever you want', and so I felt like it balanced out in the end but it's not easy it's not … you just have to give up some stuff.

Though her heart desired to complete the professional development work she was doing with her original graduate supervisor, Hypatia moved out of province, not knowing if she would ever get the chance to finish the work she started on Indigenous culture and mathematics education. This decision was in response to her father falling ill and she knew that she needed to move closer to be able to support him.

Hypatia considered doing a PhD following her graduate studies, stating that she would "love to do the research" but it was not financially responsible. In addition, she only had an interest in doing professional development with educators at the time, and she knew that a PhD was not required for that.

As Hypatia described her early learning experience, it was evident that she was committed to supporting those around her in mathematics. She mentioned that she was a "bad student" and would "sit in the bathroom smoking cigarettes, helping her friend with their math homework for hours on end". She shared that throughout her career, she has been the "go to" person when administration asks for help with after school tutoring. Her commitment to her children's education was apparent in the ways that she advocated for their learning experience in mathematics, including the financial expense of sending them to an alternative outdoor education program.

Family. The importance of family appeared as a prominent subtheme of Hypatia's commitment and sacrifice. She described the experience of not hesitating to move closer to her father when he became ill. It seemed to be the natural decision for her and there wasn't a question about her personal goals, because someone else needed her. The decisions she has made have been a result of her commitment and unwavering love towards her family. When I asked how her commitment to family impacts her role as an academic, she paused for a minute, then responded:

> When you're a mom you spend most of your life trying to balance, work, your own stuff and your kids' stuff, and I think [working in academia has] changed how I spend my free time so that I can be at home, more. You know, when I was younger, I liked to get out of the house to do things, but as a parent, I've tried to find things to do in the house so that I can be around. With teenagers you don't need to be present that much, but you need to be available…they want to talk when they want to talk and if you're not around, then you don't get to talk … but as a single mom with a demanding job and two teenagers like it's just, it's always been crazy.

Her commitment to family was most apparent as she shared the intimate aspects of her life including her previous marriage. She shared the struggles of addiction and loss during our conversation and confessed that she needed to leave the marriage as a means for survival. It was very evident that her children remain her number one priority as her decisions appear to be surrounded by her children's best interests.

Relationships

Early on in the interview Hypatia identified her relationship with her father to be an important aspect of her journey. She portrayed their relationship as one of the many reasons for her continued commitment to mathematics, specifically during secondary school when she felt the external pressure to conform to gender norms. The importance of relationships weaves throughout her narrative from her experiences in early education where she felt supported by teachers to her role as a mathematics educator. A large part of her early participation in mathematics was based on a positive relationship with her teachers and their willingness to understand her needs as a student. Hypatia emphasized the importance of relationships in the classroom—both in learning mathematics and in learning about her students—and indicated that she spends a lot of time establishing these connections. In describing the importance of relationships, she elaborated on her experience working as an educator in a small northern community, stating:

> I would go to the grad every year and just stand at the back end bawl my eyes out because I knew those kids from the time, they were little, sometimes babies … to finish grade 12 is a huge accomplishment for a lot of them, and they had fought with me for years about during their math homework, and there they were, they did it! It helps put things in perspective, like, I think I spent more time in grade 10 telling stories and

> chatting about life than most people would but I knew that … they were my students, that was going to keep them in class and keep them in school.

She further explained that a large part of her job involves listening to her students. As a result of her personal experience, she indicated that she has always been interested in therapy and counseling, and teaching allowed her to help individuals cope with anxiety towards mathematics.

Emmy's Story: Freedom in Letting Go

I hadn't noticed.
I excelled at most tasks.
There was never any doubt that I could do math.
I hadn't noticed.
When they taught me, I sat there;
Compliant, I listened.
I won all the math games; everyone knew I was proficient.
I hadn't noticed.
When I'd have to explain what it meant,
That I'd realize my understanding
was grounded on false pretense.
Bewildered and inspired, eager to learn more,
You took me under your wing and together we soared.

Past: Early Years of Mathematics Education

Emmy's early experience of mathematics consisted of "copy and paste procedures". The teacher would explain a procedure, such as how to set up a multiplication question using a traditional algorithm, and students would follow the steps to solve the problem. The procedures for solving problems were unambiguous and Emmy thrived on being able to reproduce them in mathematics. Emmy reflected fondly on her elementary school experience, stating that:

> The competitive nature was brought out for me in mathematics … I liked the mad minutes, I liked being timed, I liked thinking about how to pump up my [multiplication] … like for me as a learner, whether it was false motivation or whatever, hitting that goal

> and being able to compute it empowered me … I found that because I did well in school and I enjoyed the competitive aspect of it, I always felt like I was strong.

Emmy referred to herself as a "compliant student and a good rule follower" stating that "everything was very safely done". She had very little doubt towards her abilities in school, but she enjoyed consistency. She mentioned that she "often felt that word problems were unfair because you couldn't really study for those". It seemed as though her confidence in mathematics hinged on being able to demonstrate what she knew, in the way that her teachers expected to see it. Her understanding in mathematics was based on rote practice, nothing with meaning behind it. Emmy's family was supportive of education, and she said they never needed to worry about her because she was always a strong student. Nothing was significant in her upbringing that impacted her journey in mathematics. Secondary school was very similar in terms of the copy and paste procedures and she admitted that she "coasted through". She remembered thinking that mathematics was easy because everything was presented in a "sort of sequence" and students were expected to mimic—something she could do quite well. An event that stood out to Emmy during this time is described in the following excerpt:

> I remember I had one moment in one of my math classes where I looked at the board, and I realized, I had no clue what to do because I was just super overwhelmed with life in general, I was involved in the school community and things like that, and I just kind of had overtaxed myself, and I remember being emotional and thinking, like I don't even know how to answer one question on here. So, I remember that moment [distinctly], but my teacher was very good and we just kind of got through it.

Although Emmy attributed this moment to the external aspects of life beyond the mathematics classroom, the event foreshadows her fragile understanding of mathematics, which would be realized later in life.

Emmy began teaching in elementary school following the completion of her Bachelor of Education. Embarking on her journey in education, Emmy affirmed that she wanted to have her career mapped out and understood that there were hierarchical steps that she would need to follow. She knew that after five years of teaching she would complete her Master of Education with the hope of becoming a principal. Emmy followed through on the promise she made to herself by enrolling in the Master of Education program following five years of teaching experience. In discussing her rationale for completing a Master of Education, Emmy noted that she had "ticked all the boxes" prior to this point, and confessed that:

> The decision to pursue a master's degree was the first time that I was taking something that actually wouldn't move me up a level, it wasn't going to give me any more pay, it wasn't really going to give me anything more, except I sort of had it in my head that I wanted to do it. And it's the first time also in my life that I learned, to learn for the love of learning.

At the time, Emmy enrolled in the course route with no intentions of completing a master's thesis. Emmy indicated that she engaged in writing a thesis after taking a course that drastically changed her outlook on mathematics, as well as her career trajectory. She defined this pivotal moment by stating:

> I [remember] thinking that I was very good at math [and] I thought this oh, this will be kind of interesting. During the first class [the teacher] asked us to do a problem-solving question around fractions … I remember feeling really paralyzed in that moment thinking

> I can't remember what to do and so I thought about it and I figured it out … and then she asked me what it meant, and I had not a hot clue of what it meant. I didn't know how I ended up with a whole number, I didn't know how I ended up with anything and it really shuffled me because I thought I was good enough and then all of a sudden, as I was journeying through [the] course I realized that all of my understandings were kind of on this false foundation … it also made me extremely curious … I thought I do not want my students to get to their [later years in life] and realize they think they know math but they actually don't know a thing … so I ended up doing research on fractions as my project, but it ended up growing so big that it got approved as a thesis and then my curiosity just grew from there.

Although Emmy felt that she had everything planned out and was convincing herself to follow the path she set out, she considered where she wanted to develop her skill set and the answer was mathematics. As soon as she made the decision to pursue mathematics education, Emmy shared that she felt free. She owed her expanded curiosity and involvement in mathematics to her teacher, who later became her mentor. She stated:

> This entire path of mathematics education stemmed from [my mentor], and I'm trying not to be overdramatic about it, but at the same time, it was life changing for me … When you have someone who sees in you, before you see in yourself [and] what that potential could be … I feel like [my mentor has] always sort of fostered it and always kind of kept me in that community.

Emmy acknowledged the community of people, women specifically, who have supported her along the journey to becoming a mathematics educator. She noted that those individuals both challenged and inspired her to go further than she ever would have gone on her own.

Present: Being a Mathematics Educator

Emmy continues to teach elementary, while working in academia as a mathematics educator. She sees it as a really wonderful experience to work with students at an early age—who are just beginning their math journey—while working alongside university students who see mathematical concepts come alive, having the freedom to learn in different ways. When I asked Emmy to describe who she is, she responded in the following way:

> It's interesting, I don't know if it's just because we're talking about the math, but this is funny as soon as you said, who are you, I would say, a mathematician, which surprised me … I'm also a dancer, I love to move in space, yeah those are kind of I think two big sort of passions of mine and I don't like to … yes, I'm a mother and a friend, and things like that, but I feel like those put labels on relationships.

During our conversation, Emmy allowed herself to be vulnerable, sharing some of her fears of teaching mathematics education. She admitted that it can be unsettling to sit with the discomfort as students work through problems on their own. She mentioned that it is intimidating to make sense of a student's understanding while maintaining credibility as an academic, stating that "it can be difficult not to rescue students". Emmy described one of the greatest barriers of her role in mathematics education to be not having enough time with students. She mentioned that they need more time to unpack mathematical concepts and to challenge their way of knowing mathematics. She also argued that "many teachers would love to dig deeper into math, and really explore it, and find those reasonings, and I think it's just the time and space and commitment, to be able to do so". Emmy reasoned that her desire to engage with the mathematics community—and participate further—is a result of her expanded understanding of learning new ways to look at numbers and ways to think about mathematical problems.

> In discussing the role of gender and her identity in mathematics, Emmy confessed:
>
> It's not something I think about a lot and I think it's just in the sense that all of my role models, people that I work with, are women. So, it's something that, I know it exists, but it's not something I consciously think about.

Emmy grappled with her response to questions around gender, stating that "being unaware isn't healthy either … just because my mind doesn't immediately attend to issues around gender, doesn't mean that it shouldn't". She noted that after our conversation, she would likely think more about this. Emmy suggested that if teachers refuse to acknowledge gender, they can reinforce gender bias in their own actions, recognizing that they may prioritize one voice over another or unintentionally perpetuate stigmas. She used an example of girls pulling back in mathematics when it comes to the really important questions that challenge them and argued that it shouldn't be ignored.

In discussing her personal and professional identities, Emmy suggested that they are very much connected. She acclaimed:

> I feel it in my heart when I think about math and learning, in a good way. It feels like a part of me, and so I don't know how I would separate that from a role [working in academia], because I feel like it's also a definition of what I stand by because I believe in it so much.

Emmy mentioned that the process of data collection and analysis was actually very therapeutic for her as she identified the interconnectedness of her personality with her journey in mathematics education. She noted that this is in part why her journey has been so "rewarding, and in some ways freeing" because each year she gets to dig a little deeper, become a little more curious, and get more comfortable with messy mathematics. Beyond mathematics, this journey

has become a personal one for her that has changed the way she interacts with people, how she views her students and how she views herself.

Future: Envisioning Change

Emmy firmly believes that the more individuals have an opportunity to deeply engage with mathematical content, the more empowered they will become. Emmy advocates for "messy mathematics" where students can engage in a productive struggle, one that meets them at the stage of development they are currently in. She argued that educators have a tendency to empower the wrong way, which can impact a student's confidence in mathematics. The following excerpt describes Emmy's response to the idea of raising competent learners in mathematics:

> When we make things too clean, and we end our vocabulary with "good girl", "you're so smart", "way to go", it's more damaging, I think. To build confidence, it means empowering them to work through something that's hard. I think when we make it too easy, we don't set our kids up for success.

This excerpt connects elements of her personal journey of learning mathematics with her beliefs as a mathematics educator. Her story of becoming a mathematics educator depicts a lost opportunity by learning without meaning. She has since made it her mission to teach students mathematics in a way that makes it meaningful to them as individuals. As challenging as it may be, Emmy strongly believes that in order for students to become competent math learners, there needs to be more time spent digging deeper into the mathematical relationships. She said: "if they can do that, then I think math would be a lot easier for all of us, and a lot more enjoyable too".

Central Themes in Emmy Story

Emmy's initial participation in this study was a way to pay it forward to a graduate student as she remembered her own journey, and the challenges she faced when finding research participants. She mentioned that the title of the study "Women in Mathematics" caught her eye and after reading the description, she thought it would be a nice way to reminisce on her personal journey to becoming a mathematics educator. During our first encounter, Emmy came across as warm, kind, and full of heart. It was apparent from the beginning that she was passionate about mathematics education and remained eager to learn. At various points during our conversation, she sat back and considered some of the internal tensions and challenges that she perhaps was unaware of prior to our conversation. Before our second conversation, Emmy had reviewed the introductory poem and considered the critical moments along her pathway. When presented with her emerging themes: (1) *Being a "good student",* (2) *Release of control and (3) Fear of vulnerability*, Emmy reaffirmed them as accurate descriptions of herself, referring to this process as incredibly therapeutic because it allowed her to reflect more on the aspects of her identity. One can easily sense that Emmy was taking an introspective approach and thinking deeply about her journey which made for an interesting analysis.

Being a "Good Student"

The theme of being a "good student" permeated Emmy's story, most discerningly while describing her personal attributes in elementary school. In describing herself as a student, she used words such as "compliant", "rule follower", and "safe", indicating that she valued the expectations of others. She never wavered in her belief that she was a strong student. In fact, she attributed her momentary lapse in secondary school to factors beyond the classroom, recalling that she was "emotional" and "overwhelmed" because she had "overtaxed herself". She

acknowledged that her parents never had to worry too much because she "always did well in school". Emmy mentioned that her decision to pursue a master's thesis was a result of her realizing that maybe she wasn't "good enough" in mathematics. It evolved further, based on her desire to challenge herself academically and better understand how to support the students she was working with at the time.

It wasn't until her Master of Education program where she began to understand the consequences associated with always being expected to succeed academically. In articulating her views towards this, she noted that teachers have a tendency to praise in a damaging way, using language such as, "good girl" and "way to go", leading to false empowerment. She also recognized that girls tend to be on the receiving end of these messages, being the "more compliant learners". She noted that boys are typically "expected to be more messy and more brilliant" when it comes to mathematics and sciences. She also used words such as "builders" and "creators" to describe male learners indicating that she acknowledges a gender difference when it comes to expectations in school.

Release of Control

Another lens through which Emmy's story can be viewed centers on the notion of situational control. In discussing mathematics in elementary school, Emmy shared that she enjoyed the competitive nature of it. She mentioned that she viewed problem solving questions as "unfair" because she "couldn't study for them". Emmy also shared the internal tension that exists in situations where she's required to unpack students' content knowledge, something that is beyond her control. She described the discomfort of dissecting mathematical knowledge in the following excerpt:

> At first it kind of made me freeze a little bit, like I made some big mistakes. And then, sometimes there's a perception [as an educator] that you're expected to know all of the content deeply. If I'm to look at things conceptually, especially in intermediate in high school, I would have to sit and still reason with it to unpack it.

Emmy's journey has been characterized by a release of control and a shift in mindset. The moments of uncertainty that previously made her tense, have since evolved into thought-provoking spectacles of wonder that allow her to view the world of mathematics in a very different way. Releasing her control has opened up a space in mathematics, where individuals—students and colleagues—have a voice in the subject.

Fear and Vulnerability

A fear of vulnerability is present throughout her story. The notion of being a good student comes with certain expectations and increased pressure to succeed. Although Emmy did not discuss the impact of these expectations explicitly, the way that she referred to her experiences of being vulnerable raised questions about situational control and its role in determining academic success in mathematics. She noted that she enjoyed doing things exactly as they were taught. She became ruffled when she couldn't solve a problem right away and attributed her "hardest moments" in mathematics with her most vulnerable moments. Emmy confessed: "not knowing anything is not something that usually happens to me" and so, there is an inevitable fear for her, that comes with a lack of control over a situation. She implied that the fear still exists as an educator stating: "you're expected to know everything", but she has realized that academic success is not flaunting mathematical processes or computational skills, rather academic success comes from resilience—accepting the vulnerability and being able to work through hard problems.

Ada's Story: Inspired by Wonder

As a child, I wondered…
Where my path would go
Through all the twists and turns
I knew time would surely show
I wanted to make an impact
A leader was born within
I had the support to chase my dreams
I followed my intuition
Growing up, I wondered…
Was this the right path for me
And now I sit here, looking back
And can share most confidently…
My journey was inspired by wonder
It awakened a curiosity
My arrival to mathematics education
Is where I am meant to be

Past: Early Years of Mathematics Education

Generally speaking, Ada's experience in mathematics was quite positive. She described herself as a strong student who excelled in all of her subjects because she was interested in school. Ada indicated a sense of family values noting there was never any pressure from her parents about school, in fact, it was quite the opposite. Her parents often expressed concern that she was spending too much time on homework and worrying about school. In describing her parents' outlook on mathematics education, she stated: "they encouraged learning, they encouraged education, and they encouraged my choices". She elaborated and acknowledged her parents' commitment to education by stating:

> They did everything they could to make it possible for me to focus on schooling". She confessed, "I never had a part time job when I was going through high school and [my parents] felt that it was their job to provide for me, and it was my job to go to school and to see my friends and … go to ballet and to do the things that provided a balanced

> existence, and they didn't feel that a job at that point was going to be helpful [because] it would be a distraction. I was very fortunate; a lot of kids have to work.

Her interest in physics, chemistry, and biology prompted Ada to pursue those subjects in secondary school; however, she noted that her first encounter with mathematics anxiety was in grade 9. She described this experience in the following excerpt:

> We had a teacher at the time, who was an engineer, and I remember him very well. He emphasized [that he was an engineer] a lot in his introduction of himself to the class and he reminded us constantly … and quite frankly, I didn't really know what an engineer did but I knew that it had important status … so I was intimidated by him throughout that grade 9 year, and the thing I remember most was [that] we had an exam … I remember in my head when I answered a question on the exam, I thought that I had gotten the question wrong because it was on integers and I thought that I had put the negative sign in the wrong place in my solution … I fretted for the entire week that we were off school about that mistake, and I kept telling all my friends that I thought I failed the exam and I drove my mom and dad crazy, I remember crying, I remember not sleeping, I remember not wanting to go out with my friends, because I was so anxious about this mistake … I'd magnified in my mind … now when I got back to school after the break it turned out that I did not get the question wrong and, in fact, I got perfect on the exam … however, those feelings of insecurity lingered, they were born that year in grade 9 and they lingered until grade 12.

She attributes her ability to overcome this anxiety to the mathematics teachers who were doing it “well”. In describing her positive learning experience of mathematics, she stated:

> If I reflect back on it, it was the teachers who were the role models, the inspiration, they just knew so much they just could make it interesting, they would bring in models and show you how things were moving here and there … and they encouraged us to wonder, I think that was really it.

In reflecting on her journey, Ada credits her decision to pursue education to one individual—her Grade 12 mathematics teacher—who remained an influential mentor throughout her career. In describing their relationship, she stated: "he was funny, he was accessible, he made math interesting, he joked with us and he encouraged us to maintain balance [and] to keep other interests". She recalled him allowing her to do a demonstration in front of the class on how to make strands of nylon. She said: "he encouraged me to learn how to conduct those experiments so that I could then demonstrate them, so I had to really *think*". Above all, Ada recognized that the people who influenced her in mathematics had a "humanity that exceeded the brilliance of their mathematical knowledge". She stated that "their touch was not just content, their touch was human, and by making that human connection, [it] gave permission to explore and experiment" which is what encouraged her to participate further.

Before Ada entered university, she recalled that her father's friend, who was a professor in the mathematics department at that university, gifted her a slide rule. She identified this as a critical moment—the fact that a professor of mathematics felt that she was going to succeed—and that it positively influenced her motivation to participate. In university, Ada recalled that all of her mathematics subjects were "incredibly hard". She suggested that the learning was very different from secondary school where it's "quite easy to memorize and learn the kinds of questions that the teacher is going to ask so that you can succeed". Higher education was marked by a deeper understanding of mathematics and Ada shared that it challenged her to consider

questions such as, “why” and “what does it mean”, which seemed to make more sense for teaching children as well, so everything came full circle. Building off her negative experience with integers, Ada recalled an assignment during her professional education program where she creatively designed a lesson to explain integers to students. She described:

> What I did was make a movie of the paint can being poured out and then I ran the movie backwards so that it appeared that it was filling up, so the negative was pouring the paint out and the other negative was running the movie backwards, so the two negatives actually made a positive.

Ada failed the assignment and mentioned that this was a critical moment for her as she was told by her teacher at the time that she would be “better suited as a drama teacher”. The experience propelled her further into mathematics as she decided at that point, she would “spite her professor and become the best mathematics teacher”.

It became evident that Ada’s career path closely mimicked that of her Grade 12 mathematics teacher and incidentally, it influenced her decision to teach mathematics at the secondary level. As Ada described her experience teaching secondary mathematics, it appeared that she was invested in her work and wanted to provide students with the same learning experience that she received as a student. During our conversation, she described a traumatic incident that ultimately resulted in her decision to leave her position as a secondary school teacher. The following excerpt shares her confession:

> I had prepared what I thought was going to be the ‘lesson to end all lessons’ on the quadratic function and I had worked very hard on this … I was teaching the lesson on November the 10th. I remember that distinctly … that morning the school held its Remembrance Day assembly … It was very poignant, very moving, and very emotional.

> When my students came back to class, it was clear that they needed to talk, they needed to debrief what had happened in the Assembly. They needed to have someone listen to them and understand what had just knocked their socks off during that presentation. I was a fifth-year teacher. I taught in the department, with many other sections of grade 12 math with many other teachers who were teaching grade 12 math … the exams were coming up and I made the worst decision in my life … I taught the lesson on the quadratic equation. It was dissatisfying for the students, it was dissatisfying for me I left the room in tears, and I decided that day I didn't want to teach in a system where I did not have the freedom to know my students as individuals and to have the freedom to move things around, I didn't want to be in a regimented timetable.

Despite multiple warnings from colleagues, Ada shifted gears and began teaching elementary school. She recalled many people were surprised and thought she was “crazy” because elementary level is “much harder to teach” but for Ada, it awakened a curiosity and wonder towards learning. She stated that “students of that age are still so enthusiastic and will take risks, unlike a lot of secondary school kids”.

In working at the elementary level, she found that early mathematics and young children was an area of study that she wanted to understand, which opened the pathway to her career in mathematics education at the post-secondary level. She subsequently went on to obtain a Master of Education degree and a PhD where her research focused primarily on supporting early career mathematics teachers and involving parents as partners in mathematics teaching and learning. Ada’s subsequent journey saw her become a mathematics curriculum coordinator (K-12) overseeing all of the professional development and curriculum development. While discussing her journey, Ada mentioned that she was involved in developing the first EQAO test, noting that

it was designed to be much different than what it currently is. She explained that there were actually observation periods with the kids using manipulatives and it predominantly consisted of open-ended questions. In responding to the controversy surrounding standard based testing, she openly shared her frustration, stating:

> We don't have standardized testing, we have standard-based testing … when I hear faculty members say, "we shouldn't have standardized testing", it makes me think they're totally uninformed… we need to have benchmarks [to understand where students are falling behind in terms of their learning] … now the test is punitive … it's perceived that way for a number of reasons … because of disreputable organizations … [that] rank schools on the basis of their achievement … [and it] infuriates me that real estate agents try to sell houses based on data that says the school is in an area with good EQAO tests … typically the schools that have high EQAO results are in schools where there are parents who support … so there's a lot of misinformation out there and it bothers me that people aren't jumping up to try to correct that information … you need to have multiple critical voices saying the same thing.

Following her roles in leadership, Ada decided to become an academic at the post-secondary level because it gave her the freedom to be a lifelong learner. She described her feelings towards her role in academia, stating "we get paid to learn, we get paid to think … what an extraordinary privilege".

Present: Being a Mathematics Educator

Ada has maintained a tenured position in mathematics education for over 20 years and referred to it as: "the hardest job I've ever had". The reason teaching pre-service teachers is so challenging for Ada, is because there "are not enough hours that are devoted to preparing

enthusiastic, well-meaning people who want to be in a classroom" but who are "really uncertain about their math abilities". She noted that many pre-service teachers are uncertain about how to teach mathematics and where to seek guidance. Ada firmly believes that the mathematics for primary teachers should consist of longer mandatory courses, as precursors, to equip individuals with more content knowledge. She suggested these courses be offered by the education department and not the mathematics department because "we don't want to scare people". She remarked that the field of education needs to consider what they are expecting of teachers and what the professional program of education equips them to do, suggesting that:

> Once [educators] have a solid grounding in mathematics, they are more likely to be enthusiastic, to try things, to take risks, to actually learn along with their students and to recognize what their students need to succeed, but that comes from a deep reflective understanding of the content, not a gloss over.

One of the most distressing factors that Ada brought to my attention is that "less than 50% of kids who graduate from high school actually graduate with a Grade 12 math or science credit, and that eliminates them from between 65-75% of all college university and apprenticeship programs" so one of her missions is to stimulate interest and encourage kids to pursue STEM. In addition to her role as an academic, Ada has become a champion for kids in STEM, as the director of the community outreach program. She does a lot of work around public education, family math night and family STEM in the community, through events held at local schools. The purpose of this program is to encourage children to see that there are career opportunities available for them in the STEM field which she notes isn't always considered a possibility in their home. She expanded on this in the following excerpt:

> It's really interesting because oftentimes [students] are not encouraged to go into those fields, because parents will make off-hand comments like you know those are … "what are you going to do with that area?" … there's a lot of peer influence, especially with girls who say, "you don't want to go into sciences that's for guys", so we try to work on those images of mathematics, the images of science, that kind of thing.

Ada mentioned that she won a national award from NSERC, which is the National Sciences and Engineering Research Council of Canada for the work that she has done on encouraging children in STEM fields, indicating the importance of it.

Future: Envisioning Change

When it comes to envisioning change in mathematics, Ada openly expressed her concerns with education and proposed solutions for the future. Building off her own research, Ada strongly believes that the understanding of young children's mathematical development is under studied. Ada was invited to share more about her perspective on early mathematics. She stated the following:

> The seeds that we're planting in Grade 1, are going to make a difference in Grade 12…it's much more difficult to teach math to [elementary] students than it is to take to teach calculus because, [at that point] they've already been sort of sifted through and you've got sort of the "best of the best", they're interested, they're being driven by a thousand pressures that we don't know about, some is internal motivation, sometimes motivation from parents, sometimes it's motivation from teachers, but they're there, and they are driven to do well, because of the fact that they want to go somewhere.

One of the reasons this topic remains undervalued is due to the perception of early mathematics. Ada stated that "mathematicians would look down on early mathematics and say, 'oh that's just

trivial' and they would think that people who taught early mathematics are really not as smart as the teachers who teach calculus which is completely backwards". Ada believes that students' lack of engagement in elementary school is a result of their "teachers primarily, and their parents secondarily", stating that she has been in far too many classrooms where it is quite evident the teacher doesn't like math, or they don't understand it. She implied that teachers negatively impact student participation in the language that they use to describe mathematics, stating: "[teachers] will make throwaway comments like 'math is hard' and 'we're going to learn something hard' … what they do is they actually set the kids up in terms of permission to not do well or not to like the subject". Ada suggested that the negative attitudes that teachers hold towards mathematics evidently impact the perceptions of the subject.

Additionally, mathematics seems to have a bad reputation in society. Ada was invited to share her perspective of how mathematics is perceived by society at large. Ada stated the following:

> Mathematics has a bad reputation in society. Self-respecting adults will never say "I can't read". It just never happens. But adults will tell you all the time "I failed math five time, the math gene doesn't run in my family, I never saw any purpose for doing math, I don't like math" … and every time a parent says something like that, it just puts another little chink in the in the brain of the kid that says well, my dad's a real great person [and] my mom's a real great person, if they don't like math and they never needed to learn math, then why do I … [students] are bombarded all the time, the media bombards them with images of math people who are "nerdy" and "goofy" … so unless we actually start to respect math as a society as something that is needed … and celebrate those options that

> are not always university related and until we again stop streaming kids into dead end programs, in which they're not respected and valued, then we don't have a chance.

She also emphatically believes that the goal of high school should not be for every student to graduate and go to university. She indicated that the push for students to attend university comes from both teacher and parents stating:

> If you look at who most teachers are, they come from comfortable middle-class families who want more for their children want better for their children, or they come from successful families who you know, want to provide more opportunities for their child to take over the family business or whatever it may happen to be so in the end they're pushing university.

Ada believes that all members of society should have at least some functional numeracy skills so that they can participate fully but she insists that above all, we need to "value different kinds of abilities, and different kinds of knowledge, and different kinds of endpoints".

Central Themes in Ada's Story

During our first encounter, Ada was comfortably seated on her couch next to a bright big window that gave a glimpse of the snowfall—a picturesque setting. Ada's new puppy accompanied her during our call, eager to make his video debut. As she shared her story, I was taken back by the wealth of knowledge and experience that she had to offer. I left our conversations with many questions about her path and career changes. There was much to learn about her identity beyond the surface level and I feared we may not get a chance to unveil those critical aspects due to the time restrictions. During our conversation I came to realize that Ada is a teacher who cares deeply about her students and the experiences they receive in education. It was also evident that she wishes to make an impact beyond the classroom.

Ada was clearly unique in the sense that she was the only interviewee in this study who reflected on a positive early experience in mathematics. This is a stark contrast from the other participants and provided a fascinating lens to view women's experience and participation in mathematics. As one can imagine, uncovering the full story of Ada's journey in mathematics would have been a challenge, due to the usual time and space constraints associated with a master's thesis. Nonetheless, Ada was able to capture the essence of her mathematics experience within a two-hour time frame. In spite of numerous contextual and temporal transitions throughout her story, a couple themes have been an undying constant: (1) *The power of influence and higher expectations and (2) Leadership outreach and impact.*

The Power of Influence and Higher Expectations

Ada has been heavily involved in mathematics since the beginning of her journey as a student in elementary school. She implied that power of influence and higher expectations from both her parents and teachers, played a critical role in shaping her perception towards mathematics. More specifically, Ada spoke at length about her Grade 12 teacher who provided creative opportunities for her to participate and demonstrate her knowledge in various ways. She noted that she remained close friends with her teacher who later became her mentor and acknowledged that her career path largely shadowed his. Her involvement in various roles pertaining to mathematics education suggests that she holds great influence within the mathematics community to this day.

Her parents also played a critical role in Ada's participation in education by providing opportunities for her to succeed. Ada noted that she never worked during secondary school because her parents wanted to give her the best possible experience, which included a balance of academic and social commitments.

It appeared that Ada held high expectations of herself, presumably a result of the education she received as a student. She mentioned that she spent a significant amount of time on planning her lessons as a secondary school teacher and reflected deeply about her success as an educator. As I listened to her stories, it was clear that the influential figures in her life gave her a space to share her knowledge, which later increased the expectations of herself as her journey had come full circle and she now represented that person of influence.

Leadership: Outreach and Impact

Throughout our conversation, the theme of leadership evolved. Initially, Ada can be seen as a leader within her class, showcasing her understanding of mathematical content. Given the rarity of women in calculus, some might even call her a leader of her time, going against normative gender associations. The various positions that she has held within the mathematics education community establishes her as a leader within the space. She noted that her involvement and development of EQAO was a result of her desire to progress into a leadership position. While listening to her story, I got the impression that Ada was someone who would succeed in any role. She appeared driven and confident yet, unassuming. The way that she articulated her vision for mathematics education was indicative of her ability to motivate others and make a positive impact on the community. She maintains leadership within her university through her research, as a director of the community outreach program, through her award-winning creative projects, and as an educator to pre-service teachers of mathematics. During our conversation, she stated “I see my classroom as the world”. She further explained that her role as an educator extends beyond the classroom, stating: “I want to dispel the myth that math is the bad guy and if that means having a casual conversation with somebody in line at the grocery store who's complaining about [not understanding the] discount, then I’ll teach that”. She

acknowledges that the ability to teach mathematics in any context comes with “experience, confidence and reflection”. In sharing her own description of a leader, she stated:

> [Leaders] recognize that not no one person is ever going to change this world, not *one* person is ever going to have the influence to change a math curriculum or change the way teaching is done, but if we can influence a critical mass of people in positive ways, we have a better chance and you [can] only do that by removing the barriers to who you are, as a person, and who you are as an educator and who you are as a mathematician so you have to strip away those walls, so that people see that you are accessible, you are genuine, you are real, and that you are not contrived.

Her goal is not to hold on to power that comes with being a leader, rather she works tirelessly in equipping others with skills to be ambassadors for change and to have the opportunity to become leaders themselves.

Chapter Five

Analysis: A Cross Comparative of Interpersonal Connections

"We all move forward when we realize how resilient and striking the women around us are"

— Rupi Kaur

Preamble

I separate my exploration and analysis of these findings into three sections: first, "*On The Love for Education*" for data about the personal experiences of women's participation and teaching mathematics education at the post-secondary level; second, "*On The Invisible Barriers for Women*" for information specifically relating to the obstacles that participants have overcome, including issues of gender and identity; and third, "*On Articulating Goals for Mathematics Education"* which reviews participants' visions for students, teachers and society. Throughout this section, I contextualize my findings through connections to the literature as appropriate.

Key Findings

On The Love for Education

Desire to Teach

Throughout our discussion, the women of this study were challenged to address the topic of gender and confront whether it had any bearing on their decisions in life. Many women in this study suggested that they became an educator because they wanted to make a difference. In describing her decision to become a teacher, Hypatia stated that "meaning for [women] comes with helping people often"; indicating that for her, the decision to become a *teacher* is what led to mathematics education. This was consistent across all participants' experience and is most noticeable in their recollection of transitioning into being a teacher at the post-secondary level.

All participants described their transition into academia as "hard" and it became evident that this was a result of these women feeling as though they were giving up a piece of themselves. The underlying assumption expressed by participants was that academia would not allow women to devote as much time to teaching which, at the heart of it, is what they loved to do. Hypatia noted that "the academic side is really pushed" implying that the amount of time dedicated to personal research and career development becomes more important than the amount of time spent teaching. The women of this study rationalised the idea of "giving up a piece of themselves" by considering the greater impact that they could make on mathematics education, in teaching pre-service teachers.

The Collective: Importance of Belonging to a Community of Practice

All women in this study spoke at length about their connection to the *mathematics education* community and suggested that their membership exists on the periphery of the *mathematics* community. Julia admitted that she feels a different dynamic between conferences that consist of mathematics educators and those that included the mathematics community. In addition, she described public scrutiny of her research publications stating that she has been attacked for claiming the title of a mathematician when working with a member of the pure mathematics community. Consistent with this view, Ada suggested that mathematicians would "look down on early mathematics educators" and consider them as "less intelligent". Sophie noted that her research focuses mainly within mathematics education and said, "it's only very rarely that I would go and read a purely mathematical text". Considering the distinction between the two communities, Emmy affirmed "I think of them as very separate worlds".

What these women share is a sense of belonging within their community of practice which has anchored them in *mathematics education*. All of the women in this study reported a

connection to their community of practice and used words such as “supportive”, “inspiring”, “encouraging”, “empowering” and “pretty snug”, to describe the relationships found within.

Challenges Within Mathematics Education

In speaking of their community of practice, all five women shared a unified goal of deepening pre-service teachers’ understanding of mathematics while changing negative perceptions towards it. In doing so, they hoped that teachers would model similar teaching practices and positively impact future generations. Hypatia suggested that one of the greatest challenges of her role is the lack of time spent with pre-service teachers. In addition, she mentioned that class sizes have increased which means that she “can’t provide the same kind of feedback and one-on-one attention” to her students. Ada also identified a lack of time as being the greatest obstacle of her role in mathematics education. She stated:

> There are not enough hours that are devoted to preparing enthusiastic well-meaning people, who really want to be in a classroom but [who are] really uncertain about their math abilities … and they're really uncertain about how to teach math … and they're really uncertain about where to go for help.

Ada explained that pre-service teachers need longer classes and mandatory courses offered through the faculty of education in order to equip individuals to teach mathematics.

Julia shared that she has witnessed classroom teachers leaving notes for supply teachers that say, “I hate math so I leave it until the end of the day, and I hope that we run out of time” and suggests that those individuals should not be working in a classroom. All women admitted that the majority of individuals who enter the professional teaching program are grappling with their own insecurities towards mathematics. The insecurities are unsurprising given that the majority of students enrolled in the education program are women, who are more likely to underestimate

their mathematical ability (Jacobs, 2010; Statistics Canada, 2019b). When they graduate, they are only a step ahead of their students and Ada suggests that:

> This creates enormous problems, because unless you actually understand the mathematics, unless you actually are interested in mathematics and unless you understand the applications of the mathematics you can't make it interesting, you're making it boring and pedantic it becomes a textbook exercise, so I believe that one of the reasons that girls fall off in math more than boys, is simply because it's boring.

Likewise, Emmy believes that there are so many teachers who would benefit from digging deeper and exploring mathematics but agrees that time and commitment is an obstacle. Emmy suggests that the obstacle of time creates a deficit because "some people who fear the math don't have the time to really uncover and find those relationships to realize that they can be really great in math". In sharing her personal experience, she recollects how much she has grown as an educator and a learner. By participating in mathematics more frequently, she shared that she becomes "a little more curious and a little more confident".

On The Invisible Barriers for Women

Internalizing Identity

Before participants shared their personal reflections, I asked them to answer this question: "who are you?" All women who answered that question associated their identity with their role as a mathematics educator. This informed my understanding of their perspectives towards identity as they appeared to highlight aspects of themselves to fit a particular social situation. When we research women's lives, it's important to consider how narrative frameworks and storylines are created using experiences that are available to them to make sense of their lives (Woodiwiss, 2017). In this context, it's possible that my role as a researcher influenced

their decision to associate with being a mathematics educator. I wondered: *Did they perceive my question as a test? Did they assume that I wanted them to associate with being an educator in mathematics? Had my initial call for mathematics educators influenced the way they defined themselves as a participant in this inquiry?* When asked about her identity, Emmy shared that she was surprised that a "mathematician" came to mind. Confirming my presumption, Emmy admitted that it was possibly due to the topic of inquiry—women in mathematics and education.

In describing who they are, women in this inquiry made no reference to their gender. Woodiwiss (2017) suggests that this is a natural reaction stating that "the stories we tell are only ever partial, and we vary them not only according to what we want to say but who we might want to hear, and indeed the contexts or circumstances of their telling" (p. 17). My question then became: *why did these women not acknowledge gender as part of their personal identity?*

In the process of deciphering where their major differences lie, in terms of their lived experiences, several women in this study directed their attention to issues of gender along their pathway and the minimization of it. I got the sense that within the privacy of their homes, constructs of gender had very little impact on their lives on a day-to-day basis. All women in the study indicated that their parents were supportive of education and never felt as though their career options were limited based on their gender. In fact, in Hypatia's case, her mother advocated for her participation in previously male dominated careers. Julia mentioned that her family emphasised gender norms more subtly, stating that although she was encouraged in school, getting married and having children was the true indicator of success in life.

Minimizing Gender

The theme of minimizing gender was noticeable in the way that each woman shared their experiences with me as a researcher. For Emmy, being a "good student" was a defining feature

of her identity. Emmy's story echoes Butler's (1993) notion of performativity that suggests that women often tend to fit the mould of what is expected by "performing". Emmy openly shared that she was not acutely aware of gender issues although she mentions that maybe she should be. Unpacking Butler's (1993) notion of performativity, Lane (2018) argues:

> Individuals may contribute to or challenge gendered power relations through ways they performatively cite gender stating, the norm of sex takes hold to the extent that it is 'cited' as such a norm, but it also derives its power through the citations that it compels. While alternative or non-conforming gender representations may be viewed as failures or impossibilities, they also destabilize notions of fixed or static gender. (p. 13)

Although many of the women in this study identified themselves as being a mother, a partner, a dancer, a friend, a survivor, etc., none of them explicitly defined themselves by these additional roles outside of education. I began to wonder how this impacted their teaching, considering that they may only bring one side of themselves to the world of academia, leaving behind the personal meaning to their lives. Julia opened up quite candidly about this stating that when she first started working in academia, she was advised never to talk about her personal life because "as a female, it's seen as a weakness". She was told by her superior that "no matter what is going on in your life, you're not allowed to show it". This advice rang loud in Julia's mind as she recalled a moment in her teaching career where she taught a lesson immediately after receiving horrible news about a loved one. In any other circumstance, she would have cancelled her obligations and allowed herself time to grieve but not in academia. Although all women in this study did not explicitly state that this was an issue in academia, the hidden aspects of their journey that surfaced during the reflection activity suggests that women do put up a barrier between the personal and professional. A question for discussion in the following section

becomes, to *what extent do women acknowledge the intersectionality of personal and professional in the workplace and when is it acceptable and when is it not*? In addition, *who defines these parameters?*

Attainment of an Important Life Milestone

All women acknowledged isolated issues related to gender as part of their journey to becoming a mathematics educator, yet it appeared to be more challenging for them to articulate how it influenced their decisions as a mathematics educator. From Sophie's perspective, gender did not appear to be an issue within the mathematics classroom until she reflected more deeply on it. Evidently, all women had a tendency to focus on positive aspects that related to their personal accomplishments. It appeared that their arrival to mathematics education was something of which they were very proud. Although this was not explicitly stated, it was evident in the language that they used to describe their current position and their accomplishments as women in the field of mathematics education. It was also apparent in how they described some of the gender stereotypes that exist in the field of mathematics and how hard they have had to work to overcome barriers. Much of the information they shared during our initial conversation was related to their career trajectories and some of the learning experiences that they had received along the way. As the researcher, I really had to extract the more intimate experiences associated with their pathways, and I could sense that the more difficult conversations were equally, if not more, important to their journey.

Awareness in Academia

Most of the women in this study challenge the traditional rules of gender-based roles, both at home and in the workplace. They are all extremely successful in their careers and demonstrate a high level of assertiveness. All these women acknowledged that gender issues

exist but there were varying understandings of how gender plays out in the classroom and in the world of academia. Two women in this study, Sophie and Hypatia, shed light on how patriarchy in prior generations played a role in shaping their assertive and forward-thinking personalities. Hypatia, for instance, implied that her mother espoused progressive worldviews towards women membership in traditionally male-dominated fields. Her mother strongly believed in women's rights and social justice, which propelled her into pursuing her current career. Julia openly shared how her relationship with her parents dissolved due to their overly patriarchal view that because she does not "fit the mold" of having children, she is viewed as "less than" by her family. As such, Julia is acutely aware of sexism, and how it impacts her position in the world of academia. Her story highlights several encounters of gender bias while alluding to the tensions that exist between femininity and mathematics as she describes her shift in appearance to be taken seriously in the world of academia. In discussing the barriers of mathematics education, Julia shared that "gender stereotypes still exist … when we see a female, we comment on their dress or their shoes or their hair … [and] mathematics is still a boys club". This is very much in line with Adichie's (2009) Ted Talk that suggests "the problem with gender is that it prescribes how we should be rather than recognizing how we are. Imagine how much happier we would be, how much freer to be our true individual selves, if we didn't have the weight of gender expectations". She further describes that "a man going to a business meeting doesn't wonder about being taken seriously based on what he is wearing – but a woman does" (Adichie, 2009).

For Hypatia and Sophie, issues of gender became apparent during a conversation about their teaching practice as they affirmed that there tends to be a difference in how males respond to their authority. Sophie mentioned that male students often subtly challenge her by asking a random question, as if to test her knowledge in mathematics. Similarly, Hypatia disclosed that

her male students have openly stated that they will not apply the techniques they have learned in her class, claiming that their way of understanding how to solve a problem is sufficient. Prior to our conversation, it appeared that these were "acceptable" encounters with pre-service teachers within the mathematics classroom because they went unnoticed. Emmy wondered if perhaps she just was not paying attention to gender as part of her teaching, although she acknowledged that it was prevalent in mathematics. Ada did not explicitly speak to gender in regard to her classroom however, she spoke extensively about promoting girls in STEM and encouraging their participation through community outreach programs. Ada suggested that the push for technology is actually a hindrance to girls' participation, stating that girls "don't like to code because they're not doing interesting things". From her perspective, gender is a relevant issue, but she suggested that teachers and parents are to blame. Simone de Beauvoir maintains a significant reputation as one of the great thinkers of the modern feminist movement. De Beauvoir (1973) argued that for substantial change to occur within society, young boys and girls must be educated differently from the outset. The literature combined with the data obtained from this inquiry, suggests that institutions and educators should be aware of stereotype threats that exist for women in mathematics. An example of stereotype threat would be the presumption that girls are not as capable as boys in math and science. Encouraging students to think of their math abilities "as expandable can lift stereotype threat and have a significant positive effect on students' grades and test scores" (Aronson et al., 2002; Good et al., 2003). Interestingly, not one woman in this study suggested that in addition to spending more time on learning mathematics, educators could benefit from learning about gender bias and stereotypes in relation to mathematics.

On Articulating Goals for Mathematics Education

Envisioning the Future

All five women explained in their own words their philosophy of mathematics education and it was clear that they shared a communal goal. They agreed that the purpose of mathematics education is to study and investigate mathematics in "all its forms" so that pre-service teachers and their future students can begin to make connections between conceptual and contextual relationships. They share a commitment to shifting the negative perspectives and beliefs that pre-service teachers hold towards mathematics, while "deepening their understanding to a point where they feel confident that they can do mathematics". Their philosophy hinges on the idea that mathematics is a "foundational part of being human", and anyone can *do* mathematics when it is presented in a way that is easy to understand. Almost all women discussed presenting mathematics in a more invitational way that is accepting of individual learning styles.

All women described their position in academia as an opportunity to have a significant influence—on teachers, students, parents, and the community—on changing the negative perceptions towards mathematics. In sharing their vision for the future of mathematics education, it became evident that there were many obstacles that hindered their efforts and the overall success of mathematics education.

Current Issues Between Mathematics and Mathematics Education

In sharing their vision for mathematics education, all five women acknowledged that society's perception of mathematics was a significant barrier in achieving their goals. Envisioning the future of mathematics education, Julia suggested that "we need to change our mindset about the purpose of public education and what our graduates actually come out with in terms of being able to stand on their own two feet in mathematics". The women of this study

question why mathematics is valued highly over the mathematics education and suggest that society's perceptions are to blame. Julia stated that society's perception of mathematics education is that it reflects "baby mathematics" compared to the mathematics field which Ada described is perceived as an "elite field". Sophie called the perception in society "very weird" but claims that 'it has become much better than what it used to be". Connecting back to the literature, critical feminist theorists would likely take issue with Sophie's statement as it renders issues of gender as insignificant. It is precisely how institutions are able to get away with perpetuating inferiority of women, because the subtle social and personal barriers preventing women from fitting in are accepted as normal, or "improved" upon from the past (Armenti, 2004).

Discussions with women in mathematics education indicate that society perceptions towards mathematics provide an excuse for many individuals to disengage. The language that is used to describe mathematics, associating it with being hard, "gives permission for people to not do well in it". In sharing her concerns with mathematics education Ada said: "math has a bad reputation in society…self-respecting adults will never say 'I can't read'. It just never happens. But adults will tell you all the time I failed math five times". Julia and Sophie shared this sentiment.

The issue with society's widespread perception towards mathematics is that it invites a great deal of criticism, and this is significant for women in particular—as Hypatia so eloquently states, "women are more critical of themselves, because the world is more critical of us". Societal expectations put a microscope on women that operates as "a disciplinary apparatuses to control, reinforce, and uphold correct behaviour through manipulating spaces and increasing surveillance" (Foucault, 1977, p. 201). Lane (2017) argues:

> Power is not asserted or possessed but rather operates through relations (between people and institutions). These power relations influence discourses which shape ways of thinking and being in the world. (p. 19)

Therefore, the ways in which women act and construct their identities are mediated through power relations. Many women shared experiences of criticism from the mathematics community, parents, teachers and students about how they should be teaching mathematics. As a result, many of the women in this study suggest that there needs to be a more "unified message" about the purpose of mathematics education and how we can influence participation through good teaching practices.

Broader Definition of Values

In considering what needs to change in mathematics education, the "tearing down of this divide between math educators and mathematicians" appeared as a priority. All five women agreed that society needs a broader definition of mathematics. Based on the history of mathematics, mathematician Bonnie Shulman (1996) argued:

> Decisions about the future direction of the field were made in ways that were consistent with patriarchal (and otherwise hegemonic) assumptions about the world. A question to ponder is whether (and how) a woman today, even one holding a PhD in mathematics, could successfully introduce a different direction in mathematical thought and practice, particularly a direction of feminist interest. (p. 114)

Similarly, all women agreed that there is an obvious discrepancy between what type of math is valued within society, placing subjects like calculus in an "elite" group. In articulating her goals for mathematics education, Julia stated:

> At the micro-level, it means that calculus isn't the leader of mathematics … [and we] move away from computation being [seen as] mathematics … as long as our trajectory in high school is towards the calculus stream, we're going to continue to have that [inequity], because the kids who are in the calculus stream are seen as the better kids.

The hope for all women in this study, is that individuals are appreciated for the knowledge they bring into the classroom. Simone de Beauvoir maintains a significant reputation as one of the great thinkers of the modern feminist movement. De Beauvoir (1973) argued that in order for substantial change to occur within society, young boys and girls must be educated differently from the outset. The literature combined with the data obtained from this inquiry, suggests that institutions and educators should be aware of stereotype threats that exist for women in mathematics. For example, the stereotype that girls are not as capable as boys in math and science. Encouraging students to think of their math abilities "as expandable can lift stereotype threat and have a significant positive effect on students' grades and test scores" (Aronson et al., 2002; Good et al., 2003). Ada believed that the "goal should not be for all students to go to university", rather the goal of mathematics education should be to shift the understanding of mathematics to be supportive of real-world applications. Broadening values in mathematics requires educators to consider the purpose of mathematics education and how this definition influences participation. If the purpose of mathematics education was in line with Sophie's interpretation that suggests "mathematics is a foundational part of being human", then perhaps it might be more accessible to all. Similarly, Emmy described the level of abstraction to be a detriment in the sense that individuals struggle to relate to concepts that do not directly impact them. Many women indicated that alternative ways of understanding mathematics and deconstructing some of the very abstract concepts will provide entry to all students. Recognizing

that mathematics is intrinsically linked to ourselves, and the world might challenge society's view towards what mathematics is.

Summary

The findings in Chapter Five reveal a collection of themes that the women in this study experienced as they transitioned from one phase of schooling to the next. Themes emerge, then fade, and may re-emerge at a later stage alongside new themes, reflecting the interconnected relationship between women and mathematics along their evolutionary journey. The following chapter will discuss how these findings may support women's participation in mathematics and how their personal narratives relate to their decisions in mathematics education.

Chapter Six

Discussion and Conclusion

"It's impossible for someone to imagine themselves as a subject in the process of becoming without having, at the same time, a disposition for change. And change of which they are not merely the victim but the subject".

(Freire, 1998, p. 44)

Preamble

Is this really the end of our journey? Why does it feel unfinished? How can we maintain the relationships that we've built? Have I gathered enough information? What have I learned from listening to these women? How do I make sense of their lives? Why is it important that I share these women's stories? Have I done enough? What have we changed?

Leaving my final interview, I was not prepared to write about my participants' lives without ever speaking to them again. Our conversations sparked a curiosity inside of me and their personal pathways inspired me to continue on a pursuit towards equity in mathematics. The following story is my most recent critical moment along my pathway to becoming a changemaker for women in mathematics.

Situating the Researcher After the Inquiry

The hardest aspect of this journey has not been overcoming obstacles, although there have certainly been many, but rather, the hardest part has been acknowledging how far I have come and how much I have grown—as an individual, a researcher, a learner, an educator, and a changemaker. Listening to women's experiences in mathematics has confirmed the high expectations that we tend to hold over ourselves and our ability to "perform". There were many days when my inner voice echoed my participants' experiences of confronting fear and learning

to sit with the discomfort of not knowing. Although I had considered how meaningful this inquiry would be to me, I was overwhelmed by how meaningful it became for my participants. Their pathways were rife with critical moments of being silenced, feeling excluded and having to prove their value. By listening to their stories and becoming a part of their lives, even if momentarily, I hoped to have made a difference. When I had completed my data analysis, I remember being terrified to send my participants the poem that introduced their narrative. I was afraid that it would fall short of their expectations or worse, the possibility of misinterpreting their story completely. During our follow up conversation, Hypatia smiled at me through tears as she expressed her gratitude for being *seen* in her poem. Other women described their participation in this inquiry as "therapeutic", as they discovered new ways of understanding their lived experiences and were given the time to reflect on them. It certainly made me feel proud and honoured to know that I had touched their lives. It affirmed my commitment to this work and provided me with a sense of purpose.

The diversity of our individual journeys is linked together through the goal of improving students' view of their place in mathematics; and by extension, how they view their connection to the world. As each woman envisioned the future of mathematics education, it became apparent to all of us that there is still a significant amount of work that lies ahead in terms of making mathematics more accessible and equitable for women. I believe that part of that work encompasses providing women with opportunities to share their personal stories and experiences in mathematics. To look beyond the performance or the grades, and to understand how women relate to mathematics as *individuals*. Storytelling allows researchers to take a holistic approach that values the identity of the individual within the context of their lived experience and to

recognize the deeper meanings of storytelling: “to listen, to hear and to be changed” (Driessens, 2018, p. 229).

Prior to this inquiry, I do not know if I knew how to truly listen. To listen without judgement or preconceived ideas, to acknowledge my bias and leave my assumptions at the door; to disengage from my own construction of meaning was a skill I acquired throughout. I will admit, when I entered this journey, I had preconceptions about women’s participation in mathematics based on my own experiences that I shared with you at the beginning of this inquiry. It was an ongoing effort and conscious decision to reflect on my own experiences and to separate them from what these women were sharing with me, so as not to confuse the two. Listening intently has allowed me to become more aware of the language we use to share our stories, and how meaningful the words are behind the stories we tell. I am forever changed in how I think and interpret the world. For these reasons, I am eternally grateful to have persisted along this pathway and to be standing in the present—my critical moment of becoming a changemaker for women in mathematics.

Research Questions Revisited

This inquiry shares the personal pathways—including experiences, thoughts, and stories—of women mathematics educators within the context of the three-dimensional narrative inquiry space (Clandinin & Connelly, 2000). I specifically focused on Canadian women who were mathematics educators at the post-secondary level. Although each woman’s pathway was unique, there was considerable overlap across all five narratives. Their stories shed light on the various factors that influence women’s participation while revealing some of the invisible barriers that women face and their envisioned goal(s) for the future of mathematics education.

To begin, I revisit the overarching research question that guided this inquiry as well as the secondary research question with a focus for improving women's participation in mathematics. I will then explore and discuss the inquiry's findings in relation to the research question and provide suggestions for future implementations and further inquiries.

Question 1: Question of Participation

Why do women decide to teach mathematics education at the post-secondary level?

Each woman's journey to arrival in mathematics education was influenced by a myriad of factors including family expectations, schooling experiences, social interactions, and their personal beliefs. Above all, the women in this study shared a mutual desire to become an educator which is consistent with the enrollment rates of women in education compared to those in mathematics. They each described a passion for teaching that evolved in their own unique ways. In addition, their transition to the post-secondary level was a result of them considering the greater impact on the mathematics community through training pre-service teachers.

Although all women associated with being "strong students", there was a striking difference in the level of interest, their abilities, and achievements in mathematics specifically at various points along their pathways. Although I was searching for a connection among interest and ambitions, it didn't appear that there were any of notable significance. The women in this study appeared to be driven to continue their education as a form of self-improvement. All the women stated that they enrolled in higher education to better support their students in the classroom. They emphasised the importance of their knowledge being valued in higher education as they each encountered a "moment of awakening". Each woman experienced an awakening in mathematics that came from a deeper understanding and reflection of mathematical concepts.

Question 2: Question of Experience

What are the experiences of women mathematics educators who had "overcome barriers"? What are the critical moments along their pathway to participation?

Their personal narratives revealed the unique circumstances of each woman's experiences and how the more intimate details of their lives contributed to their decision to pursue mathematics education. As women shared the critical moments to arriving in mathematics education, they each described feelings of being marginalized at least once along their path. For some women, this was a result of their teachers placing a higher emphasis on rote practice as opposed to valuing the knowledge that they came into the mathematics classroom with. Prohibiting them from challenging the traditional way of knowing and doing mathematics seemed to have had a significant impact on their interest and level of participation. Other times, it was a result of societal perceptions and the social norms that existed within their mathematics classroom. More concerning were the moments shared by women when their gender directly limited the amount of power that they held within a room which appeared to be the case for at least three women in this study. This is consistent with the literature that suggests that a woman's identity is in a constant state of flux as it is negotiated between social norms and expectations related to one's gender. Understanding women's experiences has become "more complex when considering intersectionality, in which multiple forms of systemic oppression, domination or discrimination may be working in unison (Caven, 2006).

As women provided insight on how their personal narratives influenced their participation, almost all of them spoke of a male authority figure in their life who influenced their participation. It appeared that each figure influenced their pathway in various ways. Hypatia and Sophie spoke positively of their experience learning mathematics with their fathers whereas

Julia described her experience as “catastrophic”. Ada acknowledged her teachers as well as a family friend as influential in her decision to pursue mathematics, whereas Emmy’s experience with a male influence in mathematics appeared to be non-existent. The women who experienced a positive interaction with a male influence were more positive and confident in describing their experiences in mathematics suggesting that these figures increased their motivation to continue in mathematics. This is not to neglect the negative experiences of sexism that exist along their pathway, but perhaps the closeness of the relationship and higher level of respect with a male influential figure influences women’s participation differently. As I consider the possibility that women are more encouraged to accept the opinions of others who matter to them, I am reminded of Simone De Beauvoir, who openly shared her views suggesting that the world has always belonged to males and none of the reasons ever seemed sufficient (De Beauvoir, 1973). In other words, the sexist behaviour is to be expected and although they are unpleasant, the women of this study refused to regard them as truth. Those opinions hold weight, but not nearly as much as an individual who sees the potential that a woman feels inside her soul. This is an interesting comparison to the literature that suggests that mothers have a greater influence on girls’ participation in mathematics (Bleeker & Jacobs, 2004). In addition to having a positive male influence, a few women in this study acknowledged that their mothers were hardworking women who challenged some of the gender norms. Sophie’s mother worked outside of the home, and Sophie noted that this was unusual for the time period. Although the women of this study did not explicitly identify their mothers as influential figures in their participation in *mathematics,* it’s worth exploring how these relationships influenced them in general.

Similarly, as women entered the world of academia as graduate students, it appeared that the relationships they developed within their community of practice became extremely

important, if not more important than their pre-existing figures of influence, as they found a new piece of their identity as a mathematics educator. A plausible explanation for this is provided within the literature as it suggests a sense of belonging that is created within the space of like-minded individuals who share a common goal.

Implementations and Implications for Research and Educational Practice

Re-defining the Scope of Mathematics Education

In an educational system that privileges heteronormative ways of knowing, doing, and understanding (Ingram, 2013), the results of this inquiry suggest that we need to re-define the scope of mathematics education. This means that all different forms of mathematical knowledge are equally valued and represented within the educational system. Accepting the notion that mathematics is a fundamental part of being human requires educators to think about how to make learning relevant to the individual rather than have it be presented as an abstract idea which does not seem to resonate with women. All participants shared a vision for mathematics education that calls upon institutions to broaden the value that is placed on mathematics so that it is not exclusively of calculus, algebra, and statistics. It challenges the normative culture of mathematics that suggests that you are "better" or "smarter" if you are placed in the academic stream leading to university pathways (Macaulay, n.d., p. 5). For the most part, the women within this study share an underlying belief about their mathematical ability, noting that they were "strong students" in school and valued their education. Their ideas very much align with the literature that suggests that in order to be successful in life, you need to succeed and participate in school (Volman & Ten Dam, 1998). The strong focus on success in school appears to promote a "false sense of empowerment" (Singh, 2018, para 5) that compromises the natural construction of women's identity. As women navigate the educational system, their identity is

constantly being challenged—being successful becomes "etched in the consciousness of math education" (Singh, 2018, para 5).

In addition, this inquiry revealed the subconscious values of women and suggests that they associate being competent in mathematics with being successful in subjects that hold greater status. This finding goes against feminist scholars that aim to remove structural hierarchies that promote the imbalance of power. This finding speaks to the assumptions women hold about themselves and the world in relation to mathematics and suggests that even if women fundamentally disagree with an idea that supports inequity—as is the case with the participants of this study—the dominant discourse in society will prevail. In order to make a change from within an educational system, Collins's (1992) suggests that:

> One first must learn the language of the inner circle in order to understand what is being said and to gain credibility. Yet assuming the language of dominant discourse, even using the language of objectified knowledge to critique its terms, weds the thinker to the relations of ruling supported by objectified knowledge. (p. 79)

From this perspective, women who are working within mathematics education have a significant opportunity to change the discourse of mathematics education and re-define what it means to be competent in mathematics. When power is removed from mathematics, and it is no longer viewed as an elite subject that very few people gain access to, then more people have opportunities to engage in it.

Women's Development: Creating a Sense of Purpose in Mathematics

Findings from this study illuminate the importance of creating a sense of purpose for women in mathematics education. All women suggested that their disengagement in mathematics had nothing to do with their personal ability or their beliefs about their ability. Rather, their

disengagement was a result of them feeling *undervalued* by their mathematical knowledge and ways of understanding being dismissed. An ongoing concern is that the use of mathematics supports hegemonic ideologies (Frankenstien, 1983) and as such, women continue to be underrepresented within the area of STEM fields (Statistics Canada, 2019b). This inquiry uncovers how women internalize identity to fit within the social context in which they are placed. Mathematics is therefore used to understand and at times reinforce relations of power between different social groups (Gutstein & Peterson, 2005).

Although feminist researchers have critiqued the political and social beliefs and practices of patriarchal culture, the underlying theories of knowledge that support these beliefs appears to be limited (Harding & Hintikka, 1983). This study suggests that the beliefs and practices of educators does in fact influence women's participation in the area of mathematics as they become disinterested in the subject. As such, this study advocates that women's development should be anchored to a sense of purpose rather than how they are perceived in mathematics. Developing a sense of purpose comes with knowing your students and aligning their education to their personal values and providing opportunities for women to look beyond academic success, and to reimagine what is possible for them in mathematics. By connecting women with a sense of purpose, they become inspired to participate and develop mathematical literacy which Gutstein (2005) argues, allows women to interrogate unjust structures in their own lives

Conscious Praxis: Leaders within a Community of Practice

The term praxis is often used to identify the critical intersection of theory and practice when working towards action for change (Freire, 1972). Freire argued that "human nature is expressed through intentional, reflective, meaningful activity situated within dynamic historical and cultural contexts that shape and set limits on that activity" (as cited in Glass, 2001, p. 16).

The findings of this study indicate that there is an opportunity to incorporate conscious praxis as part of mathematics education at the post-secondary level. This study adds to the literature that suggests communities of practice are "grounded in candid assessments of the cultural, organizational, and individual factors shaping them" (Ibarra et al., 2013, para. 24). bell hooks (2000) claims that "we need feminist studies that [are] community-based" (p. 23) where women can "envision to collective struggle that is not on the basis of 'sameness'" (Ellsworth, 1992, p. 107).

All the women in this study indicated that their communities of practice have been relevant to their success in academia. Women shared that they were motivated and encouraged to progress within the institution knowing that they were supported by their peers. The women of this study all identified with being an educator, but their descriptions suggest that there may be an opportunity to re-envision the influence that communities of practice have and how they value individuals for who they are and what they want to become. This study reveals that it is important for students to make connections between mathematics and the world, yet most women indicated that they are removed from other communities of practice indicating that there is a missed opportunity to deeply understand how mathematics may connect. This study has shown that storytelling for example, can be a powerful way to increase women's participation in the area of mathematics education by simply allowing space for women to share their experiences. Woodiwiss (2017) argues that "not only do our stories help us make sense of what has happened and who and where we are, they also help us see or plan what could happen and who or what we could become" (p. 33). Undoubtedly, time is a restriction and that was identified in this study. However, by adopting a praxis that is critical to changing the direction of women in

mathematics, it requires educators to challenge who is making the decisions and how they are moving beyond regurgitation of information.

As seen within this inquiry, gender bias has a way of subtly creeping into organizations and it has the potential to disrupt the learning process. Supporting women's participation requires individuals to recognize and encourage one another for who they truly are. This involves providing spaces for women to come together and share their experiences without fear of judgement or assumptions. In the previous chapter, the intersectionality of the personal and professional was brought into question. This inquiry has illuminated the importance of accepting the personal identity of women so as not to teach divided from the self. Women in academia should be comfortable to bring their whole self—head and heart—to teaching, especially if their goal is to advance the progression of women in mathematics.

What Can We Learn From These Women's Stories?

Feminist narrative theorists argue that "we need better stories about women's lives" in respect to how they are shared and constrained by the political contexts in which they are constructed (Woodiwiss, 2015, p. 20). Over the course of two months, women have reflected upon their journey to mathematics education and shared their inner voice—their experiences, their feelings, and their dreams. They are inspiring as they share visions for the future of mathematics education that is inclusive, engaging, and supportive but they also illuminate the tensions that exist for women who are mathematics educators, namely the invisible barriers for women in mathematics education and the limits of their influence on women's participation. The minimization of gender in academia is a significant finding that women do not share publicly. Their thoughts and interpretations of their experiences provide a deeper understanding of why women remain disengaged from mathematics. Sharing their truth allowed me as a researcher to

uncover ways in which we might support women in the future and I can only imagine that if more women had this opportunity, we might have a chance of changing the narrative of women in mathematics.

Future Research

This study presented a variety of possibilities for future research. Studies on the alignment of mathematics educator's belief-practice remains absent from the existing literature. It would also be interesting to understand how women mathematics educators conceptualize equity at the post-secondary level and how it influences pre-service teachers' practice. In addition, supporting identity construction through stories and self-awareness in mathematics education and the influence of connections remain isolated concepts within the literature. Considering transformation within the elementary and secondary landscape, studies on feminist pedagogy are currently limited in the context of theories of knowledge in mathematics education.

Closing Thoughts

"Narrative inquiry remains an unfinished and unfinishable business"

—Jean Clandinin

The words above—offered by a guru of narrative inquiry—provide solace as I begin to write my closing thoughts of this inquiry, for it does not feel finished at all. In fact, it feels quite the opposite. I know my work has just begun as a critical feminist researcher and a changemaker within mathematics education.

The goal of this study was to better understand why women decide to teach mathematics education at the post-secondary level as well as determine how their personal narratives align with their experiences in mathematics education. It not only reveals a unique collection of

experiences that is understudied in mathematics education, but it also represents a critical first step towards social change in mathematics education through storytelling. Over the past two years, I have learned that this work takes time—something we don't have in mathematics education. Educators need time to establish positive relationships, to deeply understand their students, and to align their experience in mathematics education with their personal values. Educators need time to establish real connections within their community of practice so that they can learn how to lead with their head and heart. Above all, women need time to deconstruct the damaging perceptions towards them in relation to mathematics. As I consider this work as "unfinished business", I am optimistic about the time that I have to shape the future pathways of my students, for:

> [T]here are no shortcuts to excellence. Developing real expertise, figuring out really hard problems, it all takes time—longer than most people imagine… Grit is about working on something you care about so much that you're willing to stay loyal to it… it's doing what you love, but not just falling in love—staying in love. (Duckworth, 2016, p. 54)

I believe that my work is in fact unfinished business, as this marks the beginning of an entirely new journey for me as a changemaker for women in mathematics education.

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Appendix A:

Semi Structured Questionnaire

June, 2020

Demographic Information

1. Would you describe your gender identity as being female? * Required

   ◯ Yes

   ◯ No ***Skip to Thank you for your interest in this survey!***

   ◯ Prefer not to Say ***Skip to Thank you for your interest in this survey!***

2. Including this academic year, how many years have you been teaching mathematics education at the post-secondary level?

   _____

3. What province do you currently teach in?

   _____

4. What is your current employment status?

   ◯ Tenured

   ◯ Adjunct

   ◯ Contract/Sessional

   ◯ Other: (please specify)

5. Did you have a major, minor, or special emphasis in mathematics as part of your undergraduate coursework?
   Check all that apply

	Yes, a major	Yes, a minor or special emphasis	No
Mathematics Education	☐	☐	☐
Mathematics	☐	☐	☐
Other mathematics-related subject such as statistics	☐	☐	☐
Elementary or secondary education	☐	☐	☐

6. Did you have a major, minor, or special emphasis in mathematics as part of your graduate coursework?
   Check all that apply

	Yes, a major	Yes, a minor or special emphasis	No
Mathematics Education	☐	☐	☐
Mathematics	☐	☐	☐
Other mathematics-related subject such as statistics	☐	☐	☐
Elementary or secondary education	☐	☐	☐

Do you agree or disagree with the following statements?

Please choose the answer that best reflects your personal views, not what you think the researcher wants to hear. Feel free to share any thoughts related to your answer that may help the researcher understand your position.

Statements:

1. I have always been a quick learner in mathematics.
2. We need more women engaged in mathematics.
3. I have thought that I was "not a math person" at one point in my life.
4. I have always been confident in mathematics.
5. Learning math challenges my ideas about how the world works.
6. Do you participate in other activities or groups outside of teaching, that relate to mathematics? (e.g. research, family math nights, etc.)
7. Do you participate in other activities or groups outside of teaching, that relate to your gender identity? (e.g. women in mathematics, women in leadership, etc.)

Request for Follow-up

By participating in the survey, you allow the researcher to contact you using the e-mail provided for a follow-up interview and a reflective exercise. Please provide your name and e-mail address. You will only be contacted if the researcher selects you to participate in the study, at which point an official consent letter will be provided.

Contact Information * Required

Name:
E-mail:

THANK YOU!

I really appreciate you taking the time to complete my survey.

Thank you for your interest in my survey

At this time, I am looking for responses only from individuals who identify as being a female in mathematics education.

Appendix B:

Information Letter

June, 2020

STUDY: WOMEN IN MATHEMATICS EDUCATION: PATHWAYS TO PARTICIPATION

Thank you for your interest in potentially participating in a one-on-one follow-up interview and reflective exercise. You have already taken the survey and I would like to ask you to participate in the next phase of the research. I'm inviting you to participate in a qualitative study titled **Women in Mathematics Education: Pathways to Participation.** The purpose of this study is to investigate more deeply your personal pathway – including experiences, thoughts and stories - to becoming a woman educator of mathematics at the post-secondary level. This study will also explore what social factors (such as family beliefs, teachers, your gender identity) have encouraged or limited your participation in mathematics.

WHO CAN PARTICIPATE?

- I am purposefully recruiting 3-5 Canadian women mathematics educators at the post-secondary level who identify with having overcome barriers to succeed in mathematics.
- My request is that you commit to 1.5 hours over the next 2 months, to participate in a brief interview and complete an independent reflection exercise that produces a visual timeline of the most critical moments along your journey to becoming a mathematics educator.

STUDY PROCEDURES:

- I will ask that you participate in a **brief interview** (1 hour) and a **reflection exercise** consisting of a discussion (30 minutes) over the next three months.
- You will be asked to share your experiences, thoughts and stories on becoming a woman educator of mathematics at the post-secondary level, as well as discuss the social factors that contributed to or limited your participation in mathematics.
- This is a participatory study, and you are welcome to share your thoughts/suggestions and input throughout the process.

WHAT ARE YOUR RIGHTS AS A PARTCIPANT?

- **Your participation is completely voluntary,** and you may elect to answer whichever questions you are comfortable with.
- You will be given, in a timely manner throughout the course of the research project, information that is relevant to your decision to continue or withdraw from participation.

HOW WILL I PROTECT YOUR PRIVACY?

- Key identifying information, specifically proper names and nouns, will be removed from the future published findings to protect your anonymity. Given that I am a student at Lakehead University, I will need to rely on pre-existing relationships to generate a limited snowball sample. As a result, full anonymity may not always be possible. Additionally, by extending the invitation to your professional network, you further increase the chance of revealing your identity as a potential participant in the study as well as those you share it with.
- Your decision to participate (or not), will not affect your employment or relationship with your employer in any way. Furthermore, your employer will not know that you have participated in this survey unless you decide to tell them.

WHERE WILL DATA BE STORED?

- The information gathered will be stored at a secure location at my home office on my personal password protected computer.
- All information will be reported in such a way that protects the identity, within reasonable limits, of individual persons, schools, school districts, and communities.
- All data collected will be used for the purposes of a Master of Education thesis and potentially for subsequent research articles. All raw data (i.e. transcripts, field notes) will be destroyed using a file shredding program five years after the completion of the study.

WHAT ARE THE RISKS?

- I do not foresee any physical, financial, legal, or social risks associated with your participation in this research. However, it is possible that there may be emotional or psychological risks involved with a reflexive reflection of your role as a woman, the group, or society. I highly recommend that you familiarize yourselves with the resources available to you, at your respective institution should you require in the event of trauma or psychological injury. In addition, the Canadian Center for Mental Health and Sport provides resources available for all adults throughout Canada.

WHAT WILL I DO WITH THIS STUDY?

- Your input is invaluable and greatly appreciated! The information will be included in my Master thesis which will be housed in the Lakehead University library, in upcoming research articles, and other public spaces (conferences).
- By participating in this survey, you allow the researcher to use this information in future publications and/or presentations. Participants of the narrative inquiry will be contacted by e-mail after my analysis has been transcribed. You will have the opportunity to review your contributions to ensure accuracy and privacy. This will be done prior to any further publications.
- The findings from this study will strengthen conversations about mathematics education and promote women's participation in mathematics.

HOW CAN YOU RECEIVE A COPY OF THE RESEARCH RESULTS?

- At your request, I will be happy to forward a copy of anything I produce once the findings are assembled and finalized.
- Presentations may be made, and academic articles published following completion of this research.

WHAT IF YOU WANT TO WITHDRAW FROM THE STUDY?

- **Your participation is completely voluntary,** and you may elect to answer whichever questions you are comfortable with.
- You are under no obligation to participate and are free to withdraw at any time without prejudice to pre-existing entitlements. You may notify me by e-mail (see below for details).

RESEARCHER CONTACT INFORMATION:

- If you agree, please sign the consent letter below to acknowledge your participation.
- If you have any questions, please feel free to contact me at mtutton1@lakeheadu.ca
- You may also contact my supervisor, Dr. Gary Pluim at gpluim@lakeheadu.ca

RESEARCH ETHICS BOARD REVIEW AND APPROVAL:

- This research study has been reviewed and approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research and would like to speak to someone outside of the researcher, please contact Sue Wright at the Research Ethics Board at 807-343-8283 or research@lakeheadu.ca.

Thank you for considering my request to participate in this research. If you agree, please sign the consent letter and return it to me.

Sincerely,

Melissa Chumakov, Student Researcher at Lakehead University | Master of Education
Lakehead University, Orillia
1 Colborne Street West
Orillia, ON L3V 7X5
647-236-4149
Mtutton1@lakeheadu.ca

Appendix C:

Letter of Consent

June, 2020

MY CONSENT

I agree to the following:

- ✓ I have read and understand the information contained in the information letter
- ✓ I agree to participate
- ✓ I understand the risks and benefits of the study
- ✓ I am a volunteer and can withdraw from the study at any time throughout the research process
- ✓ That the data will be securely stored on the researcher's private laptop for a minimum period of five years following the completion of the research project
- ✓ I understand that the research findings will be made available to me upon my request
- ✓ The data I provide will be known to the researcher, but my identity will remain confidential and anonymous in any subsequent publications or presentations
- ✓ All of my questions have been answered

Please tick here to show that you agree to do the following:

Yes ☐ No ☐ I give my permission to the researcher (Melissa Chumakov) to use my images including visual reflection and/or related writings in her thesis and any articles or presentations that she might make about this project.

Yes ☐ No ☐ I give my permission to the researcher (Melissa Chumakov) to use audio recording of our conversations for recall and transcription purposes.

Yes ☐ No ☐ I give my permission to the researcher (Melissa Chumakov) to use video recording of our conversations for recall and transcription purposes.

By consenting to participate, I have not waived any rights to legal recourse in the event of research related harm.

I have read and agree to the above information and agree to participate in this research.

Name: _____

Signature: _____

Date: _____

Appendix D:

Reflection Activity

June, 2020

Dear Participant,

For this activity, I would like you to reflect on your pathway to becoming a mathematics educator. Specifically, I'd like you to start by drawing an arrow representing the movement of your mathematics journey from your earliest memory up until present day. Next, I invite you consider what the most critical moments were in leading you to a career in mathematics education and ask that you name these moments and plot them along the timeline. These moments may or may not include a specific person, and event, or a specific experience in mathematics. This is your pathway and I leave it open to your personal interpretation.

The purpose of this exercise is to understand your personal narrative and pathway to becoming a mathematics educator. I'm hoping that it gives you the opportunity to share openly and honestly, some of your struggles and successes in mathematics.

In our meeting following this reflection, I will ask you to reflect further and share stories about what was happening in your personal life during this time. In addition, I may ask what your beliefs and perceptions were towards your gender identity and mathematics over the trajectory of your timeline. You may share whatever you are most comfortable with. There is no obligation to complete the activity and you may choose to complete the activity and refuse the debrief meeting.

Appendix E:

Guiding Questions for Reflection Follow-Up

June, 2020

The purpose of this exercise is to understand your personal narrative and pathway to becoming a mathematics educator. I'm hoping that it gives you the opportunity to share openly and honestly, the most critical moments that have led you to a career in mathematics education at the post-secondary level.

1. What does success in mathematics look like for you?
2. Can you share more about why you identified these specific moments as critical along your trajectory to becoming a mathematics educator?
3. What made these moments significant to you?
4. What has contributed to *your* interest and participation in mathematics?
5. What was happening in your personal life (i.e. school, family, relationships) during this time?
6. What ideas did you have about gender during this critical moment? Prompt: what did it mean for you to be a woman at this time?
7. How were women's contributions to mathematics represented during this time?
8. What beliefs did you have about mathematics education during this critical moment?
9. What were your perceptions of women in mathematics during this time?
10. How have your perceptions about mathematics changed over time?
11. What did you learn about yourself? Prompt: Anything specific to mathematics education?
12. Is there anything you'd like to share about participating in this activity?